



Harley Dykstra

PLANNING & SURVEY SOLUTIONS



Local Structure Plan

Clifton Street South Precinct, Kelmscott

KELMSCOTT

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Date: 22/5/2017

Job No: 20176

Version: E

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ENDORSEMENT PAGE

This Structure Plan is prepared under the provisions of the City of Armadale Town Planning Scheme No. 4.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

.....19 June 2017.....Date

Signed for and on behalf of the Western Australian Planning Commission:

..........

An officer of the Commission duly authorised by the Commission pursuant to Section 16 of the *Planning and Development Act 2005* for that purpose, in the presence of:

..........Witness

.....19 June 2017.....Date

.....19 June 2027.....Date of Expiry

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.....Witness

.....Date

.....Date of Expiry

TABLE OF AMENDMENTS

| Amendment No. | Summary of the Amendment | Amendment Type | Date Approved by WAPC |
|----------------------|---------------------------------|-----------------------|------------------------------|
| | | | |
| | | | |

EXECUTIVE SUMMARY

This Local Structure Plan (LSP) outlines a land use and movement network framework for the development of Lots 20-26 Clifton Street, Kelmscott. The LSP is to be used to guide the development of residential housing on the urban zoned portions of the land at a range of medium and higher densities. It will provide for increased housing choice in Kelmscott in an attractive riverside and public parkland environment within walking distance of the Kelmscott Town Centre facilities, including shopping, public transport, schools and community sites.

The LSP reflects preceding planning implemented through the Scheme Amendments MRS 1202/41 and Amendment No. 70 to TPS No.4 (gazetted February 2014).

The LSP area itself will accommodate medium and high density residential housing and open space. The LSP area is located within the locality of Kelmscott bordered by Clifton Street to the east and the Canning River to the west. The land is situated approximately 200m east of the Albany Highway-Gilwell Avenue intersection and 2.6km south of the Albany Highway-Tonkin Highway intersection. The land is 22km south-east of the Perth CBD.

The LSP enables future subdivision and development to create residential lots, incorporating a range of residential densities (R40-R80). The LSP provides for local Public Open Space (POS) and for subdivision and development creating a Canning River Foreshore Reserve on the eastern foreshore of the Canning River. In time, and over progressive stages, the Canning River Foreshore Parkland will extend between Brookside Avenue and the Martin Street Parkland Reserve which link Clifton Street and the historic "Three Logs Crossing" at the Canning River. The vision for a future Canning River Foreshore Parkland was formulated through Community Workshops for the "Canning River Community Consultation Study" (2005) and the seminal "Kelmscott Enquiry By Design Workshop" (2003).

The LSP Summary Table below details the nature and key outcomes of the LSP.

| ITEM | DETAIL | SECTION No. within LSP Report (Part 2) |
|---|------------------------------------|---|
| LSP Area | 6.66 ha | Section 1.2.2 |
| Land Use Area: | | |
| <ul style="list-style-type: none"> • Residential • Public Open Space • Bush Forever | 3.87 ha 0.76 ha 0.10 ha | Section 7.3.1 Section 7.3.2 Section 7.3.2 |
| Estimated Dwelling Yield | 383 dwellings | Section 7.3.1 |
| Estimated Residential Density: | | |
| <ul style="list-style-type: none"> • Dwellings per gross urban hectare • Dwellings per site hectare | 58 dwellings/ha 99 dwellings/ha | Section 7.3.1 Section 7.3.1 |
| Estimated Population | -770 people | Section 7.3.1 |

The Clifton Street South Precinct LSP will guide development of the land south of Gilwell Avenue to Martin Street. It will be complemented by separate LSP(s) for the precinct located north of Gilwell Avenue and extending to Brookside Avenue. The separate LSP(s) will be prepared at a future time by landowners and the draft plan will be subject to a further public review and comment process.

The City's vision for the staged Canning River Foreshore Parkland is to enhance the natural environment of the Canning River Foreshore with restoration planting and meandering trail for walkers and public seating provided for quiet contemplation and nature study. The subdivision and development guided by this LSP will provide the foreshore reserve land with appropriate tenure allowing for management by the City of Armadale to protect the Canning River and its riparian and fringing vegetation. The Canning River Foreshore Parkland will be implemented in stages to provide new opportunities for local passive recreation in a natural setting within the heart of Kelmscott. The City of Armadale will subsequently conduct design and management studies for the foreshore and parkland areas with the aid of community and public review input.

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APPENDIX B – BUSHFIRE MANAGEMENT PLAN & DFES APPROVAL (RUIC FIRE)

APPENDIX C – LOCAL WATER MANAGEMENT STRATEGY & DoW APPROVAL (BAYLEY ENVIRONMENTAL SERVICES)

APPENDIX D – TRAFFIC IMPACT ASSESSMENT & TECHNICAL NOTE (SHAWMAC)

APPENDIX E – SERVICING REPORT (SHAWMAC)

PART ONE – IMPLEMENTATION

1.0 Local Structure Plan Area

The Local Structure Plan applies to Lots 20-26 Clifton Street, Kelmscott being the land contained within the inner edge of the line denoting the structure plan boundary shown on the Local Structure Plan Map (**Plan 1**).

2.0 Operation

This Local Structure Plan shall come into operation on the date when it is approved by the Western Australian Planning Commission (WAPC).

3.0 Land Use & Subdivision

The Local Structure Plan Map (Plan 1) outlines land use, zones and reserves applicable within the Local Structure Plan area.

3.1 Land Use Permissibility

Land use permissibility within the Local Structure Plan area shall be in accordance with the corresponding zone or reserve under the Scheme.

3.2 Residential

3.2.1 Dwelling Target

a) Objective

To provide for a minimum of 250 dwellings within the Local Structure Plan area.

3.3 Public Open Space

The provision of a minimum of 10 per cent public open space being provided in accordance with the WAPC's Liveable Neighbourhoods. Public open space is to be provided generally in accordance with Plan 1, with an updated public open space schedule to be provided at the time of subdivision for determination by the WAPC, upon the advice of the City.

3.4 Bushfire Management

3.4.1 A Bushfire Management Plan shall be prepared and implemented for the Local Structure Plan area to the satisfaction of the City.

3.4.2 All buildings erected within the Local Structure Plan area shall comply with the requirements of *Australian Standard 3959:2009 Construction of buildings in bushfire prone areas* under the Building Code of Australia.

- 3.4.3 All dwellings are to be located to ensure a maximum rating of BAL-29 or less is achieved.
 - 3.4.4 Dwellings are to be located to ensure a minimum 20m building protection zone can be achieved from dwellings at the interface with vegetation threats as required by the WAPC's Planning for Bushfire Protection Guidelines (2010, as amended). The BPZs may include setbacks, footpaths, road reserves and areas maintained in a minimal fuel state or compliant with AS3959s2.2.3.2(f).
 - 3.4.5 A Section 70A Notification shall be lodged on the Certificate of Title of each lot notifying owners/prospective purchasers that the use and development of the land is to be in accordance with the approved Bushfire Management Plan.
- 3.5 *Water Management*
- 3.5.1 A Local Water Management Strategy shall be prepared and implemented for the Local Structure Plan area to the satisfaction of the City.
- 3.6 *Movement Network*
- 3.6.1 Unless otherwise agreed to by the City, a maximum number of two full movement intersections with Clifton Street shall be permitted. The remaining number of intersections shown on Plan 1 are to be left-in/left-out configuration.
 - 3.6.2 The City may require future developers or subdividers to investigate and, if required, provide, upgrade or modify existing traffic management arrangements and devices on Clifton Street (including the intersections of Gilwell Avenue and Martin Street), if proposed development or subdivision warrants upgrades/modifications to those devices.
 - 3.6.3 Future subdivision or development on Lot 20 is to demonstrate that proposed road corners can provide a safe vehicle turning path, to the satisfaction of the City.
- 3.7 *Reports/Strategies Required Prior to Subdivision*
- Prior to the lodgement of subdivision applications to the WAPC, the following management plans are to be prepared, as applicable, to the satisfaction of the relevant authority and provided with the application for subdivision:
- a) Foreshore Management Plan (City of Armadale, on advice of Department of Water and Swan River Trust).
- 3.8 *Conditions of Subdivision Approval*
- a) At the time of subdivision, the City may recommend to the WAPC that a condition of subdivision approval be imposed requiring:

- a. A notification on the Certificate(s) of Title(s) to advise owners/prospective purchasers that land or lots may be affected by a Bush Fire Hazard, and that the use and development of the land is to be in accordance with the approved Bushfire Management Plan contained within Appendix B;
- b. The preparation and approval of an Urban Water Management Plan;
- c. The preparation and approval of a Local Development Plan(s) for all proposed lots;
- d. the preparation, approval and implementation of a Landscape Plan for proposed public open space, foreshore areas and road reserves;
- e. The preparation of an archaeological watching brief approved by the City prior to commencement of ground-breaking works on Lots 25 and 26 in accordance with Clause 4.7 of the City's Local Planning Policy PLN 3.9 River Road Heritage Area; and
- f. Satisfactory arrangements to be made by the owner/developer of Lot 20 with the City regarding the relocation of the City's existing underground bore services to road/open space reserves.
- g. The implementation of any measures to satisfy Clause 3.6 above.
- h. Any Restrictions on direct vehicle access/egress to/from residential lots and Clifton Street.
- i. Land abutting the Canning River being ceded to the Crown as a foreshore reserve in accordance with WAPC Development Control Policy 2.3 Public Open Space in Residential Areas.

4.0 Development

4.1 *Minimum Building Height*

All new dwellings in areas coded R60 and R80 on Plan 1 shall be constructed with two levels, being the ground floor and first storey. The City may exempt additions or alterations to the existing aged care facility on Lot 22 from compliance with the provision at its discretion.

4.2 *Maximum Building Height*

The maximum building height for new dwellings within the Local Structure Plan area, as calculated in the Residential Design Codes, shall be as follows:

- R60 & R80 – three (3) storeys; and
- R40 – two (2) storeys.

4.3 *Flood Fringe*

All habitable buildings constructed within the Flood Fringe, as identified on Plan 1, are to have a floor level of at least 0.5m above the relevant 1 in 100 year flood level and are subject to the approval of the City.

4.4 *Archaeological Watching Brief – Lots 25 & 26*

A condition of development approval may be applied by the City requiring the preparation of an archaeological watching brief for Lots 25 and 26 in accordance with Clause 4.7 of the City of Armadale's Local Planning Policy PLN 3.9 River Road Heritage Area.

4.5 *Further Development of Lot 22*

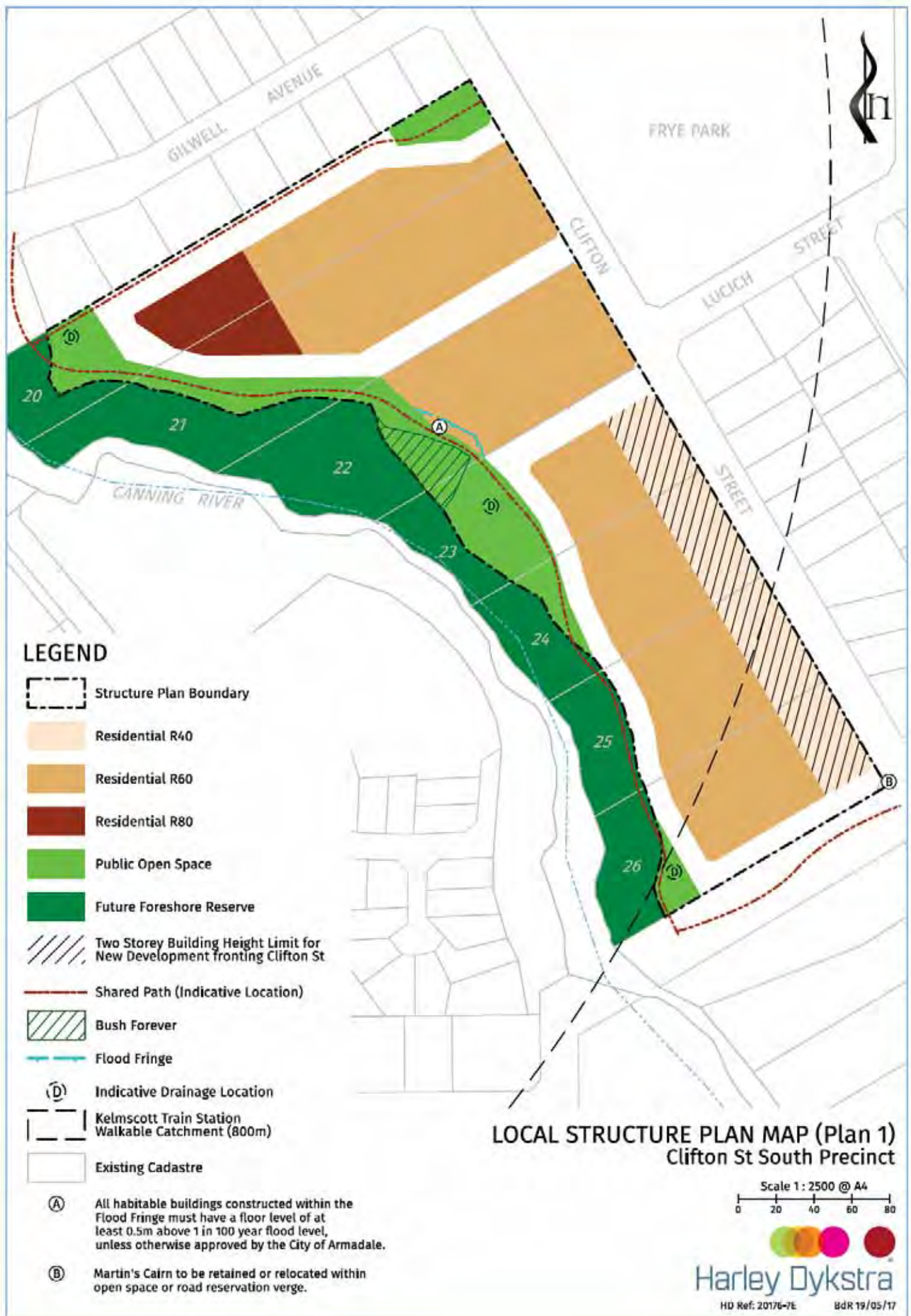
Lot 22 is currently developed for an Aged Care Facility. Approvals for subsequent staged further development of the land shall be in accordance with the Local Structure Plan and conditional upon the ceding of a foreshore reserve for the non-urban portion of the land abutting the Canning River.

4.6 *Local Development Plans*

In addition to any standard matters identified in State Planning Policy 3.1 Residential Design Codes that may be addressed through a Local Development Plan, future Local Development Plans shall provide for solar access to habitable rooms and outdoor living areas.

4.7 *Designing Out Crime*

Development plans and applications are to have regard to designing out crime principles.

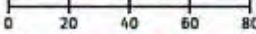


LEGEND

-  Structure Plan Boundary
-  Residential R40
-  Residential R60
-  Residential R80
-  Public Open Space
-  Future Foreshore Reserve
-  Two Storey Building Height Limit for New Development fronting Clifton St
-  Shared Path (Indicative Location)
-  Bush Forever
-  Flood Fringe
-  Indicative Drainage Location
-  Kelmscott Train Station Walkable Catchment (800m)
-  Existing Cadastre

- (A) All habitable buildings constructed within the Flood Fringe must have a floor level of at least 0.5m above 1 in 100 year flood level, unless otherwise approved by the City of Armadale.
- (B) Martin's Cairn to be retained or relocated within open space or road reservation verge.

**LOCAL STRUCTURE PLAN MAP (Plan 1)
Clifton St South Precinct**

Scale 1 : 2500 @ A4


PART TWO – EXPLANATORY SECTION

1 INTRODUCTION

1.1 INTRODUCTION & PURPOSE

This Local Structure Plan (LSP) has been prepared by Harley Dykstra on behalf of the City of Armadale, Geoff & Sharon Morfitt and Rick & Judy Buggins for Lots 20-26 Clifton Street South, Kelmscott.

This LSP has been prepared to outline a land use and movement network framework for the development of Lots 20-26 Clifton Street, Kelmscott to accommodate medium and high density residential housing and open space.

This report includes a detailed description of the proposal, provides an evaluation of the relevant town planning, environmental and servicing considerations applicable to the land and details the rationale supporting the proposed LSP layout and development requirements.

The LSP has been formulated by Harley Dykstra in collaboration with a team of specialist consultants, who have provided technical input in relation to matters as follows:

| | |
|--------------------------------------|---|
| Bayley Environmental Services | Local Water Management Strategy |
| Shawmac | Traffic Impact Assessment & Technical Note, Drainage Calculations & Servicing Report |
| RUIC Fire | Bushfire Management Plan |

1.2 LAND DESCRIPTION

1.2.1 Location & Context

The subject land is located within the suburb of Kelmscott, bordered by the Canning River to the west and Clifton Street to the east. The subject land is situated approximately 200m east of the Albany Highway and the Kelmscott District Centre, 2.6km south of the Albany Highway-Tonkin Highway intersection, 1km north of the Albany Highway-Brookton Highway intersection and 22km south-east of the Perth CBD.

The majority of the subject is located within the nominal 800m walkable catchment surrounding the Kelmscott train station, as illustrated on **Figure 1**. The subject site is well serviced by road and rail infrastructure and there are a number of existing open space and recreation facilities located within the surrounding region, as evident on Figure 1.

1.2.2 Land Use

The LSP covers the eastern portion of seven lots that have a total area of approximately 8.02ha and has its primary road frontage to Clifton Street to the east (refer **Figure 2**). The area of the LSP area is approximately 6.66ha, corresponding with the extent of the urban zoning. Lots 20 and 21 are vacant. Belrose River Gardens and Aged Care facility is located at Lot 22. Lots 23-26 each contain a single residential building and several outbuildings.



FIGURE 2 – SUBJECT PROPERTIES

REGIONAL CONTEXT PLAN

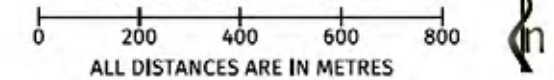
Clifton St South Precinct KELMSCOTT



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PLANNING & SURVEY SOLUTIONS

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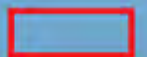


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LEGEND

PROPOSAL DETAILS

Subject Land



Roads



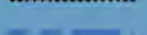
Key Roads



Railway



River



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NOTE:

This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey.

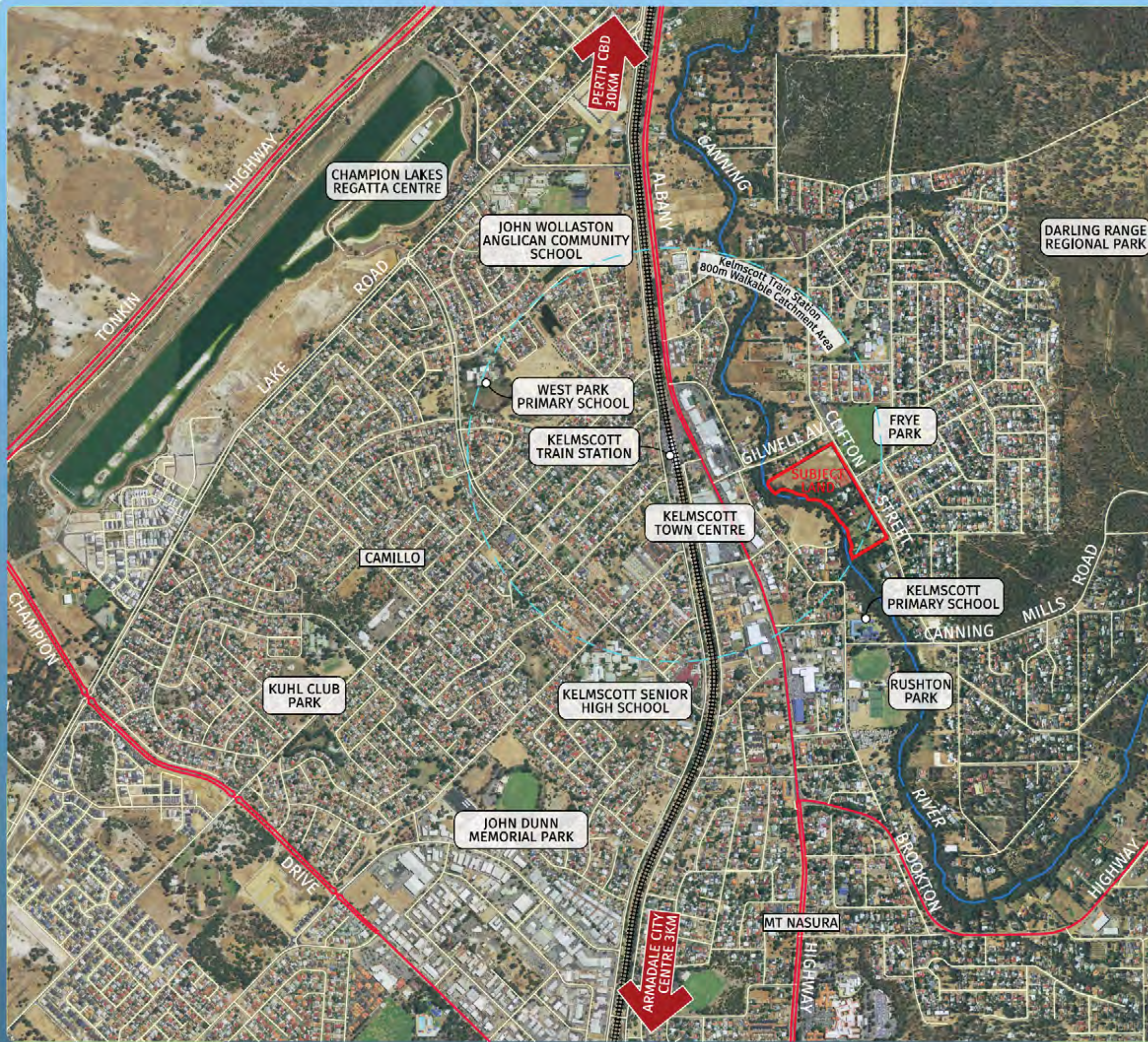


Figure 1

1.2.3 Legal Description & Ownership

The details of the properties the subject of this LSP are outlined in **Table 1** below. Copies of the Certificates of Title and Deposited Plan are included as **Appendix A**.

| Lot | Vol. | Folio | Deposited Plan | Area | Landowner |
|-----|------|-------|----------------|-----------|--------------------------|
| 20 | 1274 | 808 | 222705 | 1.4417 ha | City of Armadale |
| 21 | 1447 | 992 | 222705 | 1.6693 ha | City of Armadale |
| 22 | 1455 | 716 | 222705 | 1.2140 ha | Mercy Human Services Ltd |
| 23 | 1447 | 994 | 222705 | 0.9611 ha | Malcolm Sells |
| 24 | 1434 | 865 | 222705 | 0.8600 ha | Judith & Richard Buggins |
| 25 | 1447 | 995 | 222705 | 0.8600 ha | Geoff & Sharon Morfitt |
| 26 | 1447 | 996 | 222705 | 1.0092 ha | Anne Grayden |

TABLE 1 – LAND OWNERSHIP DETAILS

A 6m Right of Carriageway in favour of Lot 22 runs along the southern boundary of Lot 21 for a distance of 137m from the Clifton St frontage.

A 5m wide drainage easement in favour of the City of Armadale is located parallel to the southern boundary of Lot 22, running from Clifton St to the western boundary of the lot.

A Restrictive Covenant exists over Lot 22 whereby the landowner is not to develop or use the land for any purpose except a non-strata titled aged persons hostels.

2 PLANNING CONTEXT

2.1 ZONINGS & RESERVATIONS

2.1.1 Metropolitan Region Scheme

The subject land is zoned “Urban” in the Metropolitan Region Scheme (MRS). The land to the north and east of the subject land is also zoned Urban. The land immediately to the south and west is zoned “Rural” and separates the subject land from the Canning River “Waterways” reservation. A “Bush Forever” overlay also covers part of the subject land, generally following the alignment of the Canning River.

The land was formally zoned Rural and was the subject of an amendment (1202/41) that put the Urban zoning in place. The amendment became effective in the MRS on 25 May 2012 and also included land abutting the Canning River to the north of Gilwell Avenue.

2.1.2 City of Armadale Town Planning Scheme No. 4

Following the gazettal of the MRS amendment, the City of Armadale initiated an amendment (No. 70) to its Town Planning Scheme No. 4 (TPS 4) to bring it into conformity with the MRS. Amendment No. 70 was subsequently advertised for public comments, approved by the City and endorsed by the Minister for Planning, with a notice published in the Government Gazette on 14 February 2014. As a result of Amendment No. 70, the subject land is zoned “Urban Development” in the City of Armadale’s Town Planning Scheme No. 4 (TPS 4) and is covered by “Development Area (Structure Plan) 44” (refer **Figure 3**). The Amendment No. 70 Report included a diagram depicting the general principle for the provision of the required 10% local open space contribution within the new urban zoned areas (refer **Figure 4**).

The land immediately to the north is zoned “Special Residential”. The existing Clifton St road reserve (No Zone) abuts the land to the east. A Local Scheme “Parks & Recreation” reserve is located to the east of Clifton St along with “Residential R15/25”. The unconstructed Martin St road reserve (No Zone) abuts the subject land to the south.

To the west, the subject land abuts the “Rural Living 2” zone. The extent of the Rural Living area matches the Rural zone of the MRS. There are also a number of Special Control Areas (SCAs) that impact upon the western edge of the subject land. These include “Flood Prone Areas – Floodways”, “Flood Prone Areas – Flood Fringes” and “Bush Forever Sites – Outside of Parks and Recreation Reservation”. Further west, the Kelmscott “District Centre” zone is in place abutting Albany Highway.

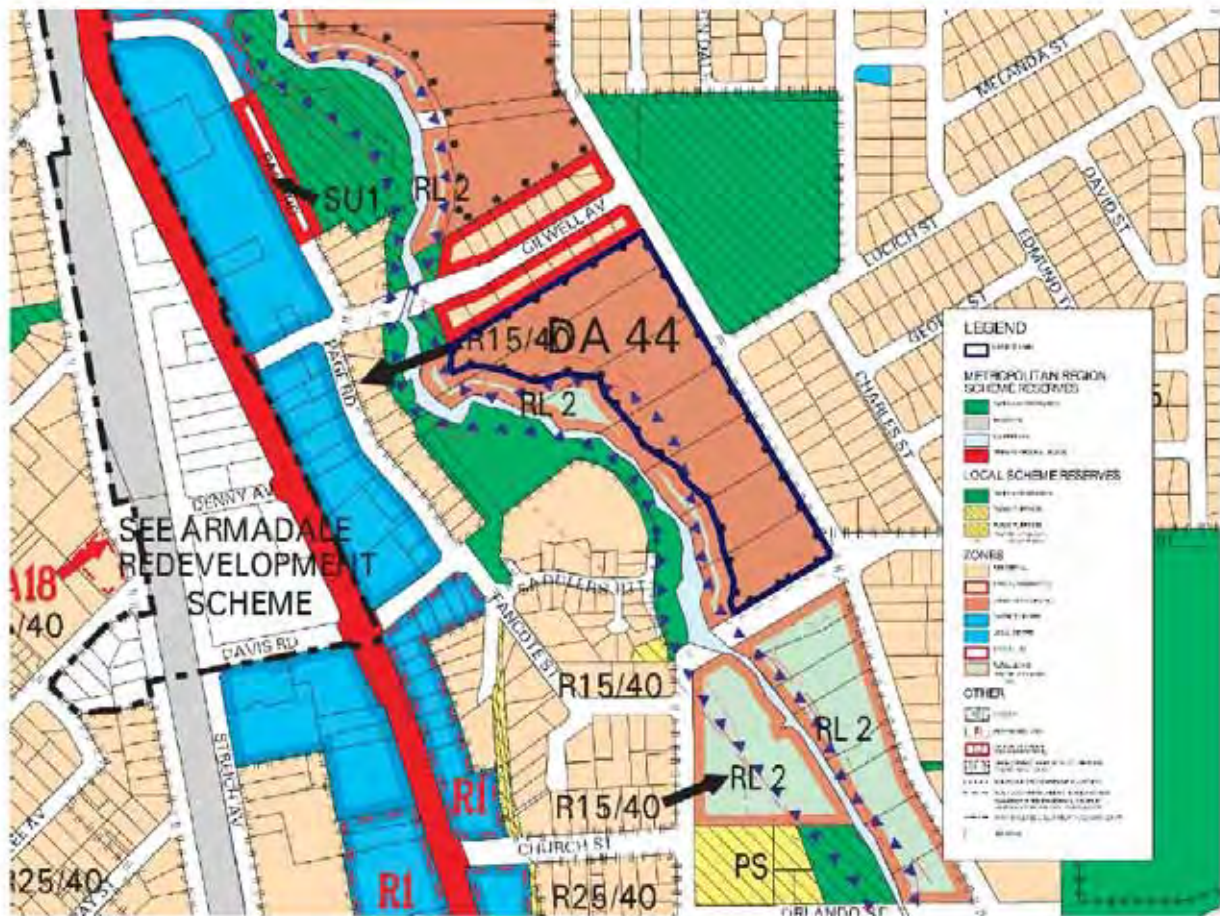


FIGURE 3 – CITY OF ARMADALE TOWN PLANNING SCHEME No. 4

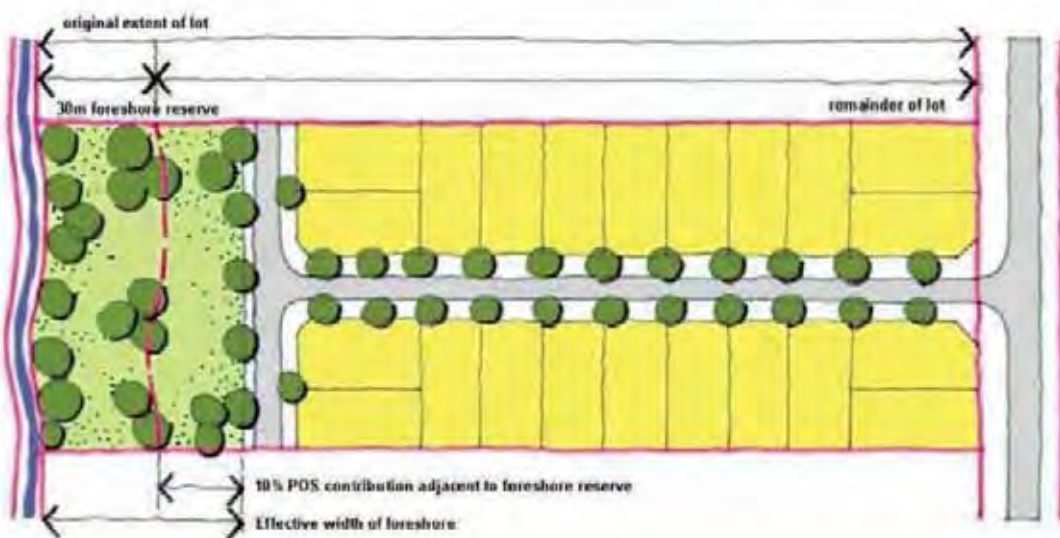


FIGURE 4 – PROPOSED LOCATION OF 10% POS CONTRIBUTION

Schedule 12 – Development (Structure Planning) Areas of TPS 4 outlines a series of additional subdivision and development provisions. These are as follows:

44.1 Subdivision shall occur in accordance with a Structure Plan for the Canning River Clifton Street Precinct Urban area which is to be prepared pursuant to the provisions outlined in Part 6A.

44.2 The Structure Plan shall incorporate assessments and recommend design and management responses to the satisfaction of the City for the following environmental planning factors:

- i) Local urban water management;*
- ii) flora and fauna, heritage sites, conservation category wetlands, bush fire protection and acid sulphate soils.*

44.3 The Structure Plan shall make provision for:

- i) a variety of lot sizes and high quality residential dwellings and respond to the preferred concept outcomes of the Canning River Precinct Study (Consolidated Scenario 4);*
- ii) protection of valued vegetation located within or adjacent to the Martin Street road reserve including options regarding the potential heritage rose bush in the vicinity of the original Martin house;*
- iii) providing an archaeological watching brief in the River Road Heritage Precinct Class B zone, which is the indicative site of the former historic police barracks;*
- iv) suitable provision of 10% standard Public Open Space contributions, predominantly by augmenting and extending the width of the Canning River foreshore reserve area, creating pocket parks, or in accordance with policies of the Western Australian Planning Commission equivalent cash in lieu contributions which can be used to improve public recreation opportunities and facilities in the foreshore POS reserve areas;*
- v) providing Canning River foreshore reserves and management;*
- vi) investigation of solar access opportunities for housing at medium and above densities;*
- vii) a Local Water Management Strategy to be prepared in consultation with the DoW and the City; and*
- viii) servicing and infrastructure requirements including any requirements for road and bridge upgrades to provide access to the additional residential development and to manage local traffic.*

In addition, *Clause 6.2 – Flood Prone Areas* of TPS 4 provides guidance regarding development requirements for land affected by the applicable SCA notations on the Scheme Maps. The purpose of the SCA designations is to highlight the potential for flooding within the affected areas and to provide a basis for the avoidance and/or minimisation of flood damage associated with extreme events. The key requirements are as follows:

- All building and earthworks within Flood Prone Areas require planning approval, at the discretion of the City and notwithstanding that the use be designated as a 'P' use in the Scheme;
- All habitable buildings constructed within the Flood Fringe are to have a floor level of at least 0.5m above the 1:100 ARI flood level;
- Where development is approved in the Flood Fringe area, special measures will need to be employed to protect the foundations from water erosion during extreme flood events.

2.2 PLANNING STRATEGIES

2.2.1 City of Armadale Local Planning Strategy 2005

The City of Armadale Local Planning Strategy sets out the longer term planning direction for the City over the next 10-15 years.

Relevant residential objectives in Section 4.1.5.1 of the Local Planning Strategy are to:

- *Achieve a better quality of living for the people of the City;*
- *Enhance the qualities and benefits of the natural and built environment; and*
- *Provide physical infrastructure with due regard to environmental impact.*

Key strategies for the Kelmscott (East) and Mt Nasura (Canning River and Foothills precinct) in Section 4.1.6.3 of the Local Planning Strategy are summarised as follows:

- *Encouraging further residential development and redevelopment that is compatible with the area's heritage, topography, natural vegetation and landscape attributes;*
- *Improving the amenity and accessibility of the Kelmscott centre by streetscape planting and enhancement of public recreation spaces;*
- *Promoting residential development of underutilised land between Brookside Ave, Clifton and Orlando Streets, River Road and the Canning River via structure planning;*
- *Protection of Bush Forever sites and other environmentally significant areas; and*
- *Ensuring subdivision makes provision for connecting green link corridors for wildlife and public open space along creeks and major bushland reserves.*

The LSP directly responds to the above objectives of the Local Planning Strategy by facilitating the development of an underutilised portion of land for residential development. Development of the subject land offers future residents convenient access to Kelmscott District Centre and open space surrounding Canning River, while having due regard for environmental considerations.

The Local Planning Strategy identifies the need for population growth to be managed appropriately to ensure that adequate facilities are provided in locations that enhance the liveability of the City and that adequate job opportunities, services and retail facilities are provided in existing Town Centres in the City. Sections 4.1.7, 4.2.8 and 4.3.2 of the Strategy note that the following strategic approaches are required to achieve these objectives:

- *Providing for increased densities around commercial centres at Kelmscott and Armadale, near local centres, proximate to railway stations and in other locations favourable for access to facilities;*
- *Including structure planning and detailed development area provisions and planning controls for new subdivisions;*
- *The provision of a greater range of densities with medium density codings for both single house and grouped dwelling development in strategic locations; and*
- *Encourage higher density housing within and adjacent to the Centres to ensure that a greater number of residents can take advantage of job opportunities, services and shopping convenience and to encourage life in the Centres after hours.*

The LSP seeks to provide the opportunity for the development of a greater diversity of residential housing options in close proximity to the existing Kelmscott District Centre and train station.

2.2.2 City of Armadale Local Planning Strategy 2014

The City of Armadale Local Planning Strategy (LPS), released for public comment from late October to early December 2014 reflects the planning intent for the 2015-2025 period. The LPS was adopted by Council in March 2015 and endorsed by the WAPC on 23 December 2016. The LPS informs future directions for land use change and development control in the municipality, and guides future consolidation of, and amendments to, Town Planning Scheme No. 4.

Overall objectives and key features of the spatial Strategic Plan in the LPS include the following:

- *Provide for a variety of development to meet the needs of the community with regard to housing, employment and services, and to facilitate the provision of a wide range of social and cultural facilities and services;*
- *Improve access and integrate land uses with the available and extended public transport systems throughout the district;*
- *Consolidation, infill and refurbishment of housing in established residential areas which are well located in proximity to community facilities, public transport and services.*

The Housing Strategy component of the LPS identifies that the City of Armadale will remain as a place where a range of high quality of living environments can be enjoyed with:

- *Meeting the housing targets as identified in the Directions 2031 Annual Report Card (2012) and influencing the housing mix (particularly for one and two bedroom dwellings) as per Direction 2031 Report Card (2012).*

- *Future urban growth focused in and around retail and employment centres, transit-orientated development and high frequency public transport corridors.*
- *Higher R-Codes applied to areas that have close proximity to community facilities and service.*

The following relevant Housing Strategy actions are outlined in the LPS:

1. *Increase density potential around the main centres (particularly the Strategic Metropolitan Centre) to R60 and R80 or higher subject to design requirements.*
4. *Continue to pursue the provision of deep sewerage to the unsewered residential zoned parts of Kelmscott and Forrestdale.*
5. *Clarify under clauses 5.2.4 and 5.2.5 that multiple dwellings would be permitted subject to the achievement of the relevant criteria and amend the Scheme Zoning Table to indicate that Multiple Dwellings are D (not permitted unless the City has exercised its discretion by granting planning approval) in the Residential Zone rather than D/X.*
6. *Amend the Scheme to provide Scheme clauses to give greater incentive to develop specific housing types, such as maisonettes and one and two bedroomed dwellings in residential zones.*
7. *Introduce local planning policies to reduce front setbacks and open space requirements to reflect prevailing Local Development Plan provisions in designated new suburban development areas.*

The LPS provides high-level policy support for the development of new higher density residential facilities in close proximity to the Kelmscott District Centre and nearby services in accordance with the principles and objectives of the LPS and subject to applicants providing detailed information and plans and achieving a satisfactory outcome in regulatory planning application assessments.

The Bushfire Protection Strategy component of the LPS identifies the following relevant actions:

3. *Ensure that bushfire risks and impacts in new areas of closer subdivision and development are reduced and minimised by implementing a Bushfire hazard analysis and preparation of Bushfire Management Plans in risk areas from the earliest stages in planning assessment processes at the rezoning, structure plan, subdivision and development stages;*

A Bushfire Management Plan (BMP) has been prepared in support of the LSP and is included as **Appendix B**. The BMP assessed bushfire risks and outlines the necessary mitigation requirements.

Part 2 of the LPS provides high level information on a number of urban development matters which may be relevant to this LSP, including reference to Water Corporation servicing and setback variations which the City may consider. Firstly, the LPS states that the Water Corporation has advised that the extension of the urban zone to accommodate future residential development west of Lake Road, north of Forrestdale, within the Ranford Road precinct and within the Canning River precinct can be accommodated within the Water Corporation's water and sewerage planning.

Secondly, the LPS makes mention of regular variations to the R-Codes which have been supported by the City in its approval of Detailed Area Plans for new developments. These include reductions in the required front setback to between 2m and 4m and support for setbacks to laneways being 1m. Detailed relevant information is provided in this LSP report, particularly to indicate water and sewer servicing requirements for the Canning River South Precinct.

2.3 CITY OF ARMADALE LOCAL PLANNING POLICIES

2.3.1 Water Sensitive Design (PLN 2.6)

The policy applies to structure plans, subdivisions and development proposals throughout the City of Armadale and seeks to enhance the qualities and benefits of the natural environment by:

- *Protecting the beneficial uses of the Canning River and watercourses.*
- *Ensuring water sensitive design best management practices are implemented for all new proposals so as to minimise nutrient and other pollutant export to the City's Rivers;*
- *Protecting and where possible restoring and enhancing environmental and social (i.e. recreational and scenic) values of waterways and protected wetlands;*
- *Retaining or enhancing open drains by converting them to multiple use corridors that provide habitat for wildlife and passive recreation opportunities wherever possible;*
- *Ensuring that upland vegetation is considered for protection in addition to wetland vegetation;*
- *Fringing vegetation along watercourses and around protected wetlands and associated significant upland vegetation for retention and rehabilitation where practical.*

All development along watercourses, main drains and overland flow paths for the 100 year storm recurrence interval shall have floor levels at least 300mm above the 100 year flood level. This is a minimum standard, and the City prefer floor levels to be 500mm above the 100 year level, particularly in areas with heavy soils.

Major watercourse and main drainage reserves should be of sufficient width to allow for 1:6 batters, appropriate access for maintenance, and the floodway associated with the 100 year event. This would normally result in a minimum reserve width of 30m. However, to allow for natural meandering of a watercourse and the flood plain, a 50m reserve width is preferred. Fringing vegetation associated with wetlands should not be removed from within buffer zones. Where significant upland vegetation is associated it should be considered for retention. The recommended size of buffers is as follows:

| | |
|---|-----|
| Watercourses with permanent water or protected wetlands | 50m |
| Seasonally flowing watercourses | 30m |
| Watercourses which flow in response to specific rain events | 10m |

2.3.2 River Road Heritage Area (PLN 3.9)

The objectives of the River Road Heritage Area are as follows:

- *To enhance conservation of the heritage significance and character of the River Road Heritage Area.*
- *To enhance protection for individual buildings and places within the boundaries of the River Road Heritage Area identified as making a contribution to its heritage significance.*
- *To enhance protection for landscape areas and significant trees that contribute to the heritage character of the River Road Heritage Area.*
- *To guide development and maintenance of future and existing buildings, structures and landscaping in a manner that respects and enhances the heritage significance and character of the River Road Heritage Area.*

Within the policy area, Council will not consider demolition approval on the grounds that redevelopment is a more attractive economic proposition alone. Council may consider demolition of a place on the grounds of structural inadequacy. A structural assessment completed by a suitably qualified engineer must be submitted to the City's satisfaction and at the applicant's expense to demonstrate this. All demolitions in the River Road Heritage Area require planning approval.

Clauses 4.2 and 4.3 of the policy contain provisions and design guidelines that apply to alterations, additions and construction in the River Road Heritage Area. As per the note for the Class B Zone on Figure 1 of the policy, these clauses do not apply to development on Lots 25 and 26 Clifton Street.

Furthermore, the policy may need to be reviewed and updated to reflect the built form vision outlined in the LSP for Lots 25 and 26.

For lots located within the Class B Zone, the City may request an archaeological watching brief for any property within the River Road Heritage Area if there is reasonable evidence to suggest that the property may contain archaeological artefacts that will contribute to the knowledge or understanding of the history and significance of the area.

An archaeological watching brief may be applied as a condition of a planning approval or strata/subdivision approval requiring development work to stop in the event that archaeological artefacts are found to enable the artefacts to be inspected and if necessary, excavated by an historical archaeologist. An archaeological watching brief is required for subdivision and development on Lots 25 and 26, and specific clauses are included in Part 1 of the LSP which enable the City to apply conditions in this regard. Within the River Road Heritage Precinct, archaeological artefacts may include footings or other evidence of former structures or any elements that might provide information of former uses of the site.

2.4 OTHER RELEVANT DOCUMENTS

2.4.1 City of Armadale Municipal Heritage Inventory

A series of sites of heritage significance are located in close proximity to the LSP area. The City of Armadale's Municipal Heritage Inventory (MHI) identified "Martin's Cairn" as being located on Lot 26 Clifton St. An analysis of aerial photography and cadastral data, however, suggests that the cairn is located within the existing Martin/Clifton St road reserves.

This stone cairn is constructed of local laterite stone with random rubble coursing. It stands around 1m in height and features a marble plaque commemorating the erection of the first house built in Kelmscott (refer **Plate 1**).

"Martin's Crossing and Rosebushes" are also listed on the MHI and are located adjacent to Lot 26 Clifton Street within the road reserve. All that remains of the former river crossing is a pair of partly submerged logs located in the section of the Canning River between River Road and Fancote Street (refer **Plate 2**). The logs provide limited pedestrian access across the river and connect to an established track within the unconstructed portion of the Martin Street road reserve.

The bushland that lines both sides of the track includes a number of rose bushes extending for approximately 50m along the north boundary (refer **Plate 3**). The rose bushes are estimated to be 150 years old and are considerably overgrown.

The LSP has due regard for heritage listed sites in the vicinity of the subject land.



PLATE 1 – MARTIN'S CAIRN



PLATE 2 – MARTIN'S CROSSING



PLATE 3 – EXISTING ROSEBUSHES, MARTIN ST ROAD RESERVE

2.4.2 Kelmscott Enquiry by Design Workshop (2003)

The opportunity for infill urban developments close to the Kelmscott Town Centre was considered in the Kelmscott Enquiry by Design (EBD) Workshop which was held in 2003 and led by the then Department for Planning and Infrastructure. The EBD process provided an opportunity to investigate how to revitalise the town centre and make it more able to adapt to economic and social changes in the future. The workshop was a non-binding event that allowed a range of suggestions to be freely canvassed and tested.

The workshop process incorporated community consultation through a series of focus groups to gain a better understanding of the issues in the Kelmscott town centre and, through the invitation of a broad range of community and stakeholder representatives, to provide feedback to the workshop.

The workshop was also an opportunity to apply the principles of best practice sustainable urban design and to encourage ideas about how to make Kelmscott more “future proof”.

The Kelmscott EBD process identified the development of additional residential facilities in the area generally located between the Canning River and Clifton St, with a desire to increase the residential catchments of the town centre and public transport infrastructure and protecting more of the river foreshore. The EBD process also suggested that a new street pattern in the area should create vistas and lead people towards the river.

2.4.3 Canning River Precinct Community Consultation and Planning Study (2005)

The Canning River Precinct Community Consultation and Planning Study (2005) was commissioned by the City of Armadale and examined the preferred future land uses within the Canning River Precinct. The study sought to explore and establish the best outcomes for the Canning River precinct and the broader Kelmscott town centre by balancing the protection of the foreshore and ecosystem of the Canning River with appropriate development opportunities for landowners with land next to the river. The report of the study subsequently formed the basis for the MRS amendment request referred to in Section 2.1.1 above.

The study saw the preparation of three different scenarios and the presentation of these scenarios to the community for consideration and feedback. The three scenarios proposed different levels of development, namely no additional development (Scenario 1), single residential development (Scenario 2) and medium density development (Scenario 3). Scenarios 2 and 3 received the most favourable comment and a Consolidated Scenario 4 was subsequently prepared (refer **Figure 5**).



FIGURE 5 – CONSOLIDATED SCENARIO 4

Medium density development (R40) is envisaged for the area covered by this LSP. An indicative urban design and landscape strategy was prepared for the precinct, which demonstrated the following:

- *A street layout integrated with the surrounding existing streets to allow direct physical and visual access to and along the river foreshore*
- *A subdivision layout with lots for residential development with frontage onto public reserves*
- *A path system in the foreshore on both sides of the river (as continuous as possible and taking into account existing land uses or constraints)*
- *Existing and future parks.*

2.5 WAPC PLANNING DOCUMENTS

2.5.1 Directions 2031 and Beyond

Directions 2031 and Beyond is the WAPC's spatial framework and strategic plan that establishes a vision for future growth of the metropolitan Perth and Peel region up to 2031. Directions 2031 objectives are based on a 'connected city' model which, inter alia, seeks to improve rates of infill development, enhance existing activity centres and encourage greater rates of use for public transport. As part of facilitating additional housing supply and sustainable urban growth, Directions 2031 and Beyond has set the following targets as medium to long-term aspirations for the Perth and Peel Region:

- A 50 per cent improvement on current infill residential development trends (30 and 35 per cent) of which 47 per cent or 154,000 of the required 328,000 dwellings should be provided as infill development; and
- A 50 per cent increase in the current average residential density of 10 dwellings per gross urban zoned hectare.

The LSP responds to the above targets from Directions 2031 and Beyond targets by providing additional infill residential development in close proximity to an existing town centre. Secondly, the development is predicted to achieve a density of 58 dwellings per gross urban zoned hectare.

Directions 2031 and Beyond also set a number of objectives to achieve liveable, accessible, sustainable and responsible development. A summary of some of the key points is provided below.

A Liveable City

- *Plan for increased housing supply in response to changing population needs.*
 - *Focus on targeted locations for future urban growth such as in and around retail and employment centres, transit oriented developments and high frequency public transport corridors; and*
 - *Apply higher R-codes in strategies and schemes within areas that have close proximity to educational institutions, community facilities and services such as hospitals, medical centres and libraries.*
- *Promote and increase housing diversity, adaptability, affordability and choice.*

An Accessible City

- *Encourage a shift to more sustainable transport modes.*
- *Plan and develop urban corridors to accommodate medium-rise higher density housing development.*
- *Plan and develop transit oriented developments to accommodate mixed use and higher density housing development.*

A Sustainable City

- *Protect and manage significant biodiversity areas.*

2.5.2 Delivering Directions 2031 – Report Card 2013

The Report Card, prepared by the Department of Planning, provides a progress report to inform government, industry and the broader community about the effectiveness of State and local government and the development industry in delivering a metropolitan-wide program of planning and development initiatives to achieve the outcomes sought by Directions 2031.

The Report Card sets revised infill housing targets which go beyond 2031 to cater for a city of 3.5m people. The targets for the City of Armadale are outlined in **Table 2** below. It is evident that a significant number of infill dwellings will need to be provided within the City of Armadale as the population of Perth expands.

| Local Government | Total Additional Dwellings to 2031 | Additional Dwellings After 2031 | Total Infill Dwellings to 3.5m |
|---------------------------|------------------------------------|---------------------------------|--------------------------------|
| City of Armadale | 8,800 | 3,220 | 12,020 |
| Central Sub-Region Total | 124,880 | 45,631 | 170,510 |
| Outer Sub-Region Total | 96,080 | 35,101 | 131,180 |
| Total Perth & Peel Region | 220,960 | 80,732 | 301,690 |

Source: Delivering Directions 2031 – Report Card 2013 (WAPC)

TABLE 2 – INFILL HOUSING TARGETS

The Report Card also identifies that the City of Armadale had one of the highest population growth rates of 5.9% in the period between June 2011 and June 2012. The net site density of the whole of the City of Armadale was 9.18 dwellings per hectare, which was the fifth lowest for local governments in the Perth and Peel regions.

3 SITE CONDITIONS

Due regard has also been given to environmental protection, particularly regarding the Canning River and environs, in the preparation of the LSP. The extensive previous environmental work associated with the MRS and TPS rezonings has also been considered. Information regarding the existing physical site conditions (especially as they relate to drainage and water management) are incorporated within the Local Water Management Strategy (LWMS) included at **Appendix C**.

3.1 LANDFORM & SOILS

3.1.1 Topography

The subject site is situated on an alluvial plain immediately east of the Canning River. In the southern part, the land falls to the west at a grade of between 4.5% and 7.5%, while in the north the land is almost flat, with a slope to the west of only 0.5%. The slope increases markedly on the western edge of the project area, where the land falls into the Canning River floodway.

3.1.2 Soil Types

The development area is located mostly on colluvium, formed by erosion of material from the Darling Scarp. The Geological Survey of Western Australia (GSWA) mapped the soils of most of the project area as gravelly sandy clay. The valley of the Canning River, including parts of the western and southern edges of the project area, were mapped as alluvial sandy silt. Boreholes drilled onsite revealed silty clay soil profiles that largely matched the GSWA mapping.

Soil permeability testing indicates that surface soils have low to very low permeability, as is typical of silty clay soils. It appears that infiltration into the natural soils will be minimal and that infiltration basins will need to be engineered with imported permeable soils underlain by subsoil drains. Geotechnical reporting has not been undertaken at the LSP stage to assess permeability, however detailed geotechnical reporting will be required at the subdivision stage.

3.1.3 Acid Sulphate Soils

The Department of Parks & Wildlife (DPAW) maps the floodway of the Canning River (including the western edge of the subject area) as having a high risk of actual or potential acid sulphate soils (ASS). The majority of the subject area is mapped as low to nil ASS risk. Analysis of groundwater samples showed no significant evidence of ASS, with low acidity, high alkalinity, low sulphate, neutral pH and low metal concentrations.

3.2 HYDROLOGY

3.2.1 Surface Drainage

The low-permeability soils result in most drainage being by surface runoff. The higher parts of the LSP area, furthest from the Canning River, are generally well drained. The sloping areas closer to the river are subject to seepage and saturation in parts. Most of these are outside the LSP area.

A constructed drainage line flows within an easement in favour of the City of Armadale along the southern boundary of Lot 22, carrying street drainage from a catchment east of the LSP area into the Canning River.

Runoff from private lots within the LSP area currently flows overland to the river. The aged care facility on Lot 22 has its own detention basin located in the south-western part of the lot, with a high-level overflow into the council drain.

The major surface drainage feature of the project area is the Canning River and its floodplain, which forms the western boundary of the development area.

3.2.2 Groundwater

Groundwater exists in the clay soils beneath the LSP area and flows south-west towards the Canning River. The clay soils of the site suggest that the rate of groundwater movement is very low. Depths to groundwater (measured at the end of September 2014) ranged from nearly 6m in the north-east corner of Lot 26 to 1.34m in the south-east of Lot 21. Groundwater surfaces as seepage in winter along much of the face of the slope on the edge of the floodway.

3.2.3 Wetlands

There are no wetlands within or close to the LSP area except for the watercourse of the Canning River, which is mapped by the DPAW as Conservation Category River and Palusplain. Because it is a waterway, foreshore setbacks to the river are determined by the WAPC and Department of Water with reference to Development Control Policy 3.1 and River Restoration 16 (rather than by the DPAW).

3.2.4 Water Quality

Water samples were collected on 26 September 2014 from four bores within the LSP area, as well as the Canning River (both upstream and downstream) and the existing drain on Lot 24. The results of the water quality testing are documented in Appendix C. Water quality is generally good across the site, with low levels of nutrients, metals and acid sulphate soil indicators.

3.3 Vegetation

The LSP area is largely cleared of native vegetation. A number of mature Flooded Gum (*Eucalyptus rudis*) are located on the edge of the floodway on the western side of the LSP area. Additional Flooded Gums occur in the floodway and the river channel. The vegetation cover over the rest of the development area consists mainly of introduced trees (including exotics and non-local natives) and grasses. Landgate historical aerial photography shows that the LSP area, with the exception of the river foreshore, was fully cleared before 1953 and remained in this stage until about 1979, when a few trees had begun to regrow in some areas close to the foreshore. All trees in other parts of the LSP area have grown or been planted since 1979.

The large Flooded Gums in the floodway may contain hollows suitable for nesting of birds, although none were observed during the site surveys. No Threatened Ecological Communities or Declared Rare or Priority listed flora were found during the site surveys.

3.3.1 Bush Forever

Bush Forever Area 246 (BFA 246) is identified along the length of the Canning River, from Beckenham to Kelmscott. The majority of BFA 246 is located outside of the LSP area within the identified floodway, however portions of BFA 246 are identified within the LSP on Lots 20, 22 & 23. These areas will be protected in future local open space areas.

3.4 SITE CONTAMINATION

The Department of Environmental Regulation's (DER) Contaminated Sites Database shows no known contaminated sites on or near the LSP area. Historical Landgate aerial photography of the LSP area also shows no evidence of contamination or contaminating land uses since at least 1953 (being the date of the earliest photography). The land does not appear to have been used for market gardening, intensive animal stocking or industry at any time. The site inspection by Bayley Environmental Services in September 2014 found no visual or olfactory evidence of past or present contamination. Current land uses consist of occupied dwellings. It is concluded that no further investigation of contamination is necessary.

3.5 BUSHFIRE HAZARD

A Bushfire Management Plan (BMP) has been prepared by RUIC Fire in support of the LSP and is included within Appendix B. The BMP incorporates an assessment of the bushfire risk for the subject site, undertaken in accordance with the requirements of *State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP 3.7)* and the accompanying *Guidelines for Planning in Bushfire Prone Areas*, which takes into account vegetation cover, topography (with particular reference to ground slopes and accessibility), weather (temperature, relative humidity and wind speed/direction) and relationship to surrounding development.

4 DEMOGRAPHIC ANALYSIS

An analysis of the current housing and population trends in the Kelmscott area has been undertaken as part of the preparation of this LSP. The analysis has incorporated historical census data and future growth and demand projections. The key outcomes of this analysis are presented below, with commentary regarding the implications for the LSP layout and design.

4.1 DWELLING STRUCTURE

| Dwelling Structure | Kelmscott (2011) | | Greater Perth (2011) | | Kelmscott (2006) | | Greater Perth (2006) | |
|--|------------------|------------|----------------------|------------|------------------|------------|----------------------|------------|
| | Count | Percentage | Count | Percentage | Count | Percentage | Count | Percentage |
| <i>Separate House</i> | 3,138 | 77.2% | 492,962 | 71.1% | 3,196 | 91.1% | 418,165 | 79.1% |
| <i>Semi-detached, row or terrace house townhouse etc</i> | 171 | 4.2% | 74,518 | 10.8% | 215 | 6.1% | 62,252 | 11.8% |
| <i>Flat, unit or apartment</i> | 390 | 9.6% | 56,754 | 8.2% | 55 | 1.6% | 45,059 | 8.5% |
| <i>Other dwelling</i> | 35 | 0.9% | 2,585 | 0.4% | 42 | 1.2% | 2,819 | 0.5% |
| <i>Unoccupied Private Dwellings/Not Stated</i> | 331 | 8.1% | 66,231 | 9.6% | 0 | 0.0% | 238 | 0.0% |
| <i>Total Private Dwellings</i> | 4,065 | 100% | 693,050 | 100% | 3,508 | 100% | 528,533 | 100% |

Source: ABS

TABLE 3 – DWELLING STRUCTURE, KELMSCOTT & PERTH (2006 & 2011)

The total number of private dwellings in Kelmscott grew by over 500 in the five years between 2006 and 2011, as outlined in **Table 3** above. A large proportion of this growth was in the flat, unit or apartment category. Kelmscott, however, still has larger proportion of separate houses when compared to the greater Perth metropolitan area. There is also a relatively smaller percentage of semi-detached, row or terrace houses and townhouses in Kelmscott when compared to the wider Perth metropolitan area.

Table 4 below provides a summary of the number of bedrooms per dwelling in Kelmscott, compared to the wider Perth metropolitan area in 2011. Kelmscott has a relatively smaller proportion of both one and two bedroom dwellings.

| | Number of Bedrooms | | | | | | Total |
|-----------------------------|--------------------|--------|--------|---------|---------|------------|---------|
| | None | One | Two | Three | Four + | Not Stated | |
| <i>Kelmscott (2011)</i> | 16 | 80 | 325 | 1,969 | 1,282 | 64 | 3,736 |
| | 0.4% | 2.1% | 8.7% | 52.7% | 34.3% | 1.7% | 100% |
| <i>Greater Perth (2011)</i> | 1,643 | 21,347 | 81,477 | 239,973 | 272,590 | 10,064 | 627,094 |
| | 0.3% | 3.4% | 13.0% | 38.3% | 43.5% | 1.6% | 100% |

Source: ABS

TABLE 4 – NUMBER OF BEDROOMS PER DWELLING, KELMSCOTT & PERTH (2011)

4.2 AGE PROFILE

Table 5 below outlines how the age profile of Kelmscott and the Perth metropolitan area changed between 2006 and 2011. Changes were subtle, with a growing proportion of people in Kelmscott over 65 years of age. There was also an increase in the proportion of people in the 25-34 year old bracket. Consideration needs to be given to the housing requirements for these demographics, should these trends continue.

| | Kelmscott (2011) | | Greater Perth (2011) | | Kelmscott (2006) | | Greater Perth (2006) | |
|----------------------------|------------------|-------------|----------------------|-------------|------------------|-------------|----------------------|-------------|
| 0-4 years | 650 | 6.5% | 114,820 | 6.6% | 567 | 6.0% | 89,305 | 6.2% |
| 5-14 years | 1,161 | 11.6% | 217,588 | 12.6% | 1,301 | 13.8% | 192,911 | 13.3% |
| 15-19 years | 721 | 7.2% | 117,748 | 6.8% | 702 | 7.5% | 106,463 | 7.4% |
| 20-24 years | 672 | 6.7% | 129,182 | 7.5% | 620 | 6.6% | 107,902 | 7.5% |
| 25-34 years | 1,340 | 13.4% | 253,727 | 14.7% | 1,058 | 11.2% | 196,787 | 13.6% |
| 35-44 years | 1,233 | 12.3% | 251,418 | 14.5% | 1,271 | 13.5% | 218,067 | 15.1% |
| 45-54 years | 1,379 | 13.8% | 235,006 | 13.6% | 1,374 | 14.6% | 204,924 | 14.2% |
| 55-64 years | 1,368 | 13.7% | 193,177 | 11.2% | 1,276 | 13.5% | 155,176 | 10.7% |
| 65-74 years | 834 | 8.3% | 117,660 | 6.8% | 737 | 7.8% | 91,140 | 6.3% |
| 75-84 years | 505 | 5.0% | 70,288 | 4.1% | 379 | 4.0% | 60,870 | 4.2% |
| 85 years & over | 158 | 1.6% | 28,252 | 1.6% | 133 | 1.4% | 21,530 | 1.5% |
| Total | 10,021 | 100% | 1,728,866 | 100% | 9,418 | 100% | 1,445,075 | 100% |

Source: ABS

TABLE 5 – AGE PROFILE, KELMSCOTT & PERTH (2006 & 2011)

4.3 PUBLIC TRANSPORT USE

Table 6 below investigates method of travel to work, with a particular focus on public transport use. Public transport usage (most notably train use) in the Kelmscott area increased between 2006 and 2011. Public transport is also more readily used by Kelmscott residents when compared to the wider metropolitan area. However, total use of trains for travelling to work remains under 10% for Kelmscott area.

| Method of Travel to Work | Kelmscott (2011) | | Greater Perth (2011) | | Kelmscott (2006) | | Greater Perth (2006) | |
|--|------------------|--------|----------------------|--------|------------------|--------|----------------------|--------|
| Train Only | 265 | 5.7% | 24,100 | 2.8% | 216 | 4.8% | 14,003 | 2.0% |
| Bus Only | 52 | 1.1% | 30,602 | 3.6% | 31 | 0.7% | 27,436 | 3.9% |
| Car (Driver or Passenger) Only | 3,159 | 68.3% | 573,528 | 66.9% | 3,114 | 69.7% | 480,215 | 68.2% |
| Train & Bus | 44 | 1.0% | 13,939 | 1.6% | 34 | 0.8% | 6,756 | 1.0% |
| Train & Car (Driver or Passenger) | 52 | 1.1% | 12,317 | 1.4% | 58 | 1.3% | 6,445 | 0.9% |
| Bus & Car (Driver or Passenger) | 4 | 0.1% | 2,995 | 0.3% | 4 | 0.1% | 2,955 | 0.4% |
| Train & Two Other Methods | 23 | 0.5% | 4,698 | 0.5% | 16 | 0.4% | 2,018 | 0.3% |
| Other/Did Not Go to Work/Not Stated/Worked At Home | 1,027 | 22.2% | 195,452 | 22.8% | 997 | 22.3% | 164,289 | 23.3% |
| Total | 4,626 | 100.0% | 857,631 | 100.0% | 4,470 | 100.0% | 704,117 | 100.0% |
| Train (Cumulative) | 384 | 8.3% | 55,054 | 6.4% | 324 | 7.2% | 29,222 | 4.2% |

Source: ABS

TABLE 6 – PUBLIC TRANSPORT USAGE, KELMSCOTT & PERTH (2006 & 2011)

4.4 FUTURE PROJECTIONS

Tables 7 and 8 below provide a summary of the projected population growth in the Kelmscott area up to 2031. Tables 7 and 8 also provide an indication of the number and type of households that will be required to support the projected population increase.

| Forecast Summary | 2011 | 2031 | Change | % |
|------------------------|-------|-------|--------|-------|
| <i>Kelmscott East</i> | | | | |
| Population | 5,396 | 7,203 | 1,807 | 33.5% |
| Households | 2,090 | 2,772 | 682 | 32.6% |
| Average Household Size | 2.49 | 2.43 | -0.06 | -2.4% |
| Dwellings | 2,137 | 2,807 | 670 | 31.4% |
| <i>Kelmscott West</i> | | | | |
| Population | 5,164 | 6,873 | 1,709 | 33.1% |
| Households | 2,118 | 2,840 | 722 | 34.1% |
| Average Household Size | 2.40 | 2.37 | -0.03 | -1.2% |
| Dwellings | 2,212 | 2,920 | 708 | 32.0% |

Source: ForecastLid

TABLE 7 – PROJECTED GROWTH, KELMSCOTT TO 2031

Table 8 outlines a forecast population growth of approximately one-third, with commensurate increases in the number of dwellings. At the same time, the average household size is projected to decline marginally.

| Forecast Household Types | 2011 | 2031 | Change | % |
|----------------------------------|--------------|--------------|------------|--------------|
| <i>Kelmscott East</i> | | | | |
| Couples families with dependents | 639 | 844 | 205 | 32.1% |
| Couples without dependents | 722 | 922 | 200 | 27.7% |
| Group households | 24 | 30 | 6 | 25.0% |
| Lone person households | 452 | 650 | 198 | 43.8% |
| One parent families | 233 | 300 | 67 | 28.8% |
| Other families | 20 | 26 | 6 | 30.0% |
| Total | 2,090 | 2,772 | 682 | 32.6% |
| <i>Kelmscott West</i> | | | | |
| Couples families with dependents | 540 | 725 | 185 | 34.3% |
| Couples without dependents | 550 | 720 | 170 | 30.9% |
| Group households | 45 | 57 | 12 | 26.7% |
| Lone person households | 575 | 791 | 216 | 37.6% |
| One parent families | 341 | 459 | 118 | 34.6% |
| Other families | 67 | 88 | 21 | 31.3% |
| Total | 2,118 | 2,840 | 722 | 34.1% |

Source: Forecast.id

TABLE 8 – FORECAST HOUSEHOLD TYPE, KELMSCOTT TO 2031

It is evident from Table 8 that there is likely to be a higher demand for smaller dwellings in the future in the Kelmscott area, given the projected growth in the number of lone person households. There will be over 460 new households (couples without dependents, lone person households and one parent families) that are likely to require smaller housing in the Kelmscott East area in the future. As such, there will be a future demand in the area of the LSP to provide smaller housing options to accommodate the demographic changes of the Kelmscott community.

5 DENSITY CASE STUDIES

Some case studies have been prepared to provide an illustration of the envisaged form of development within the Clifton St South LSP area. The examples below demonstrate how the proposed densities of the LSP can be developed with an attractive, low scale built form (i.e. up to three storeys). All examples are situated in areas of metropolitan Perth that are a comparable distance from the CBD as the LSP area and located in close proximity to existing rail or road infrastructure and shopping facilities. The examples are based upon information available at the time of the original preparation of the LSP in late 2014/early 2015.

5.1 INVITA APARTMENTS, THE VILLAGE AT WELLARD – PEET LTD

Location

- Lambeth Circle, on the edge of the future Wellard Village Centre
- Approximately 400m from the Wellard Train Station.
 - 28 minutes by train to the Perth CBD;
 - 22 minutes by train to Mandurah; and
 - 4 minutes by train to Rockingham.

Proposed Development Details

- Residential density of R80 in greenfield estate.
- 46 apartments over three storeys.
- Fronting parkland.
- Mixture of one (starting at \$290,000) and two (starting at \$340,000) bedroom apartments.



Source: Invita Apartments website (<http://invitaapartments.com.au/#home>)



Source: Invita Apartments website (<http://invitaapartments.com.au/#home>)

5.2 HADLOW PLACE, THORNLIE – BROADVIEW DESIGN

Location

- Hadlow Pl, opposite the Thornlie Square shopping centre.
- Approximately 2km from the Thornlie Train Station.
 - 29 minutes by train to the Perth CBD.

Proposed Development Details

- Residential density of R80 in an infill environment.
- 20 apartments over three storeys.
- Mixture of one and two bedroom apartments.
- Prices ranging from \$329,000 to \$375,000.



Source: Realestate.com.au website

5.3 12 DAVIS RD, KELMSCOTT

Location

- Davis Rd, opposite the Kelmscott Plaza shopping centre.
- Approximately 500m from the Kelmscott Train Station.
 - 33 minutes by train to the Perth CBD.

Development Details

- Maximum plot ratio of 1.0 (equivalent to residential density of R80), in an infill environment.
- Approximately 30 apartments and townhouses over three storeys, with non-residential uses on the ground floor.
- Mixture of one, two and three bedroom apartments and three bedroom townhouses.
- Prices ranging from \$260,000 to \$330,000.



Source: Harley Dykstra

5.4 NO. 27-33 BURTON ST, BENTLEY

Location

- Burton St, near intersection of Albany & Leach Hwy.
- Approximately 2km from the Queens Park Train Station.
 - 18 minutes by train to the Perth CBD.

Proposed Development

- Residential density of R60 in an infill scenario.
- 34 two and three bedroom apartments over two storeys.



Source: Harley Dykstra

6 OPPORTUNITIES AND CONSTRAINTS ANALYSIS

An Opportunities and Constraints Analysis has been undertaken for the subject land, with the outcomes graphically depicted in **Figure 6**. Further explanation of the relevant considerations is provided below.

6.1 CANNING RIVER

The abutting Canning River provides the potential for a high level of natural amenity to be realised and provided to new residents and the wider community. Weeding and upgrading of the river environs is required as well as the establishment of a more formalised foreshore area. New picnic and playground areas could be developed in the foreshore area, similar to the area in the vicinity of Rushton Park to the south, to encourage and facilitate use of the space (refer **Plates 4 & 5** below).



PLATES 4 & 5 – EXAMPLE FORESHORE PICNIC AND PLAYGROUND AREA, RUSHTON PARK

The presence of the river also serves as a physical barrier between the LSP area and the key attractions to the west (i.e. Kelmscott Town Centre and Train Station). Consideration needs to be given to the pedestrian, cyclist and vehicle connectivity of the subject site to these attractors. Upgrades may be required to the existing Gilwell Avenue bridge in this regard. A shared pedestrian and cyclist path should be provided along the length of the foreshore parallel to the Canning River. This path could be located within a future foreshore reserve, within local open space, within new road reserves or a combination of some or all of these areas. The exact alignment should be determined at the detailed design stage.

6.2 FLOODWAY

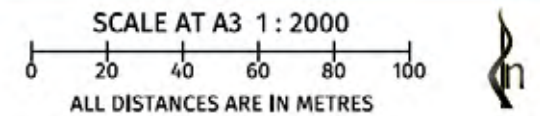
For the most part, the extent of the Canning River Floodway is located outside of the LSP area. However, the floodway does affect areas of Lots 22-24 within the LSP area. TPS 4 indicates that no private development or filing is to take place within a floodway. These areas of Lots 22-24 can therefore not accommodate urban development and are consequently a logical location for the provision of new local open space areas.

OPPORTUNITY & CONSTRAINTS PLAN

Clifton St South Precinct KELMSCOTT



Harley Dykstra
PLANNING & SURVEY SOLUTIONS



| | | |
|------------------------------|-------------------------------|------------------------------------|
| DRAWN BdR 11-02-15 | CHECKED JC 11-02-15 | DRAWING No 20176-04B.dgn |
|------------------------------|-------------------------------|------------------------------------|

| REV | DESCRIPTION | DATE |
|-----|------------------|----------|
| A | Original Drawing | 14-10-14 |
| B | Minor Amendments | 11-02-15 |

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Figure 6

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LEGEND

- Clifton St South Local Structure Plan Area
- OPEN SPACE & PHYSICAL ASSETS**
- Potential to capitalise on amenity of Canning River watercourse and associated vegetation.
- Extent of Floodplain. All development to occur outside of Floodplain area.
- Extent of Bush Forever within Structure Plan area to be retained.
- Proposed future Martin St open space area (accommodating heritage rose bushes).
- Martin's Cairn heritage monument to be retained and/or relocated with open space or road verge.
- Existing mature trees. Consider possible retention.
- City of Armadale production bores to be retained within open space.
- Possible new open space, recreation and drainage areas adjacent to future foreshore area.
- Existing drain (with easement in favour of the City of Armadale).
- Potential to capitalise on attractive views of Darling Scarp.
- LAND USE / INTERFACE**
- Existing Aged Care facility. Assume retention with future high density (R60+) redevelopment potential.
- Opportunity for higher density residential development (R60+) orientating to adjacent natural/open space amenity.
- Opportunity for medium density residential development (R40) orientating towards adjacent natural amenity.
- Consider interface to existing development.
- Consider interface with existing low density residential development and impact to new built form on Clifton St streetscape.
- Consider interface to future Martin St open space area.
- MOVEMENT NETWORK**
- Potential green link connecting Canning River foreshore and Frye Park.
- Pedestrian and cyclist linkage to be provided along foreshore, including possible upgraded connection to Gilwell Avenue bridge.
- Consider upgrade requirements for Gilwell Avenue bridge for both pedestrians and vehicles.
- Consider removal of existing Right of Carriageway and replacement with new public road connection.
- Possible new road connections to Clifton St.

It is noted that local open space in this location can contribute to the achievement of the minimum 10% public open space provision required by *Liveable Neighbourhoods*.

6.3 GREEN LINK

The subject site benefits greatly from the natural amenity of the Canning River and from Frye Park located on the eastern side of Clifton St. An opportunity exists to create a new “green link” through the LSP area that connects these two existing assets. This link could be provided at the northern edge of the LSP area and could incorporate the retention of a strand of existing mature trees in the northern corner of the site near Clifton St. The green link effect could be created with the planting of street trees within a potential new public road reserve in this location and would incorporate pedestrian and cyclist linkages.

6.4 BUSH FOREVER

The majority of BFA 246 is located outside of the LSP area. There is, however, a portion located within the Floodway on Lots 22 and 23. This will need to be retained within open space in the LSP and forms a deduction to the gross site area when calculating the public open space requirements in accordance with *Liveable Neighbourhoods*.

6.5 MARTIN ST HERITAGE CONSIDERATIONS

The City of Armadale has previously noted the possible conversion of the existing unconstructed Martin St road reserve east of Clifton St to a public open space area. This will necessitate a road closure process and public consultation separate to the LSP process. This would likely ensure the upgrading of the existing area and the protection of suspected heritage rose bushes, however the existing road reserve is under the care, control and maintenance of the City. Consideration should be given to the nature of the interface to this possible future open space area.

Martin's Cairn is located near the corner of Martin and Clifton St. This should be retained with the development of the LSP area, either in its current position within the road reserve or relocated into either a new road reserve or the possible future Martin St open space area.

6.6 VISTAS

The open nature of Frye Park provides excellent vistas to the Darling Scarp, particularly from Lots 20-22. Development in this area should seek to capitalise on these views with openings to habitable rooms and/or balconies orientated in this direction. This will also facilitate passive surveillance of Clifton St in this area and Frye Park.

6.7 EXISTING AGED CARE FACILITY

The Belrose River Gardens Aged Care Facility is situated on Lot 22. It is envisaged that this facility will continue to operate in its current form into the future. The LSP does, however, outline an applicable framework to cater for possible redevelopment in the future. It is noted that any redevelopment would need to consider the existing restrictive covenant that is in place over Lot 22 that limits development to non-strata titled aged persons hostel.

In addition, the status, form and alignment of the existing drainage easement located on the southern boundary of Lot 22, running from Clifton St to the western boundary of the lot, would need to be considered in any redevelopment planning.

6.8 CLIFTON ST INTERFACE

Consideration needs to be given to ensuring a suitable built form and development interface is achieved along Clifton St opposite the existing low density residential development (between Lucich and Martin St). The land naturally falls from Clifton St down to the Canning River. Medium density residential housing could be developed, with a two storey building height limit imposed fronting Clifton St. Higher density development could occur further down slope adjacent to the high amenity of the Canning River. Such a scenario would facilitate a transition in densities and built form scale moving west towards the Town Centre.

6.9 NEW ROADS

The City has, through the rezoning processes, previously expressed a preference for a public road interface to be provided at the edge of a future foreshore area and open space area associated with the Canning River. New road reserves can also be provided to act as a partial buffer for fire management purposes.

Some indicative locations for new road connections are identified on Figure 6. New road connections in these locations and roads generally abutting the foreshore edge will provide for a permeable movement network and the equitable sharing of road construction requirements. Some proposed new roads are located in close proximity to some existing roads (i.e. Lucich St and Martin St) and specific intersection requirements will be determined at the detailed design stage.

One new road connection is contemplated on the southern boundary of Lot 21, in the vicinity of the existing Right of Carriageway. A new road could be developed in this location, with vehicle access to the Aged Care Facility provided from the new road reserve. This would represent efficient use of land in this area as opposed to developing a new road in addition to the Right of Carriageway.

7 LOCAL STRUCTURE PLAN

7.1 VISION

The development of the Clifton St South Precinct will see the creation of high quality residential facilities that provide new and diverse housing opportunities for the Kelmscott community. These new residential facilities will leverage against and benefit from the high level of natural amenity associated with the Canning River and Frye Park and its proximity to the existing Kelmscott District Centre and Train Station.

7.2 LOCAL STRUCTURE PLAN SUMMARY

The LSP encourages the development of higher density residential facilities that seek to capitalise on the existing natural and functional amenity that is located within close proximity to the site. The key elements of the LSP are as follows:

- New residential development sites, with densities ranging from R40 up to R80;
- New public open space areas that accommodate the regional floodway requirements, serve a local drainage function and are collocated with the future Canning River foreshore area;
- Identification of land for the future Canning River foreshore reserve;
- Provision of a road interface to the majority of future foreshore area;
- Provision for new pedestrian linkages parallel to the Canning River and connecting with existing development to the east;
- Limitation of the building height to two storeys for new dwellings facing existing properties on Clifton St (i.e. south of Lucich St) to provide a suitable built form transition;
- Identification of Building Attack Level (BAL) ratings for bushfire hazard mitigation purposes; and
- Retention of nearby heritage assets.

In addition to the statutory LSP map included within Part 1 – Implementation of this report, a Concept Master Plan (refer **Figure 7**) has been prepared to provide an illustration of the development intent. This graphical representation is indicative only; however, it does demonstrate the intent for how the future built form will orientate to the surrounding public realm, with a general preference for parking to be located at the rear of the site and screened from the surrounding public realm by the new built form.

The LSP seeks to stipulate the key boundaries between land uses (e.g. between residential development and open space), address the key interface considerations (e.g. road interface to future foreshore and future Martin St open space area, building height restrictions fronting the southern part of Clifton St) and identify the key matters that need to be addressed at the detailed subdivision and development stages (e.g. BAL compliance etc). As such, the LSP affords a certain degree of flexibility for innovative and creative detailed design responses, provided that there is compliance with the key elements and principles of the LSP and the key objectives are realised.



NOTE
 This plan is for illustrative purposes only. The siting of all buildings, parking areas, crossovers, paths and planting of trees is indicative and subject to detailed design and discussion with the City of Armadale.

CONCEPT MASTERPLAN

Clifton St South Precinct

Harley Dykstra
 PLANNING & SURVEY SOLUTIONS

| | | |
|------------------------------|------------------------------------|------------------------------------|
| DRAWN Bdr 19-05-17 | CHECKED JC 19-05-17 | DRAWING No 20176-08F.dgn |
| REV | DESCRIPTION | DATE |
| D | Revised plan following SAC Comment | 14/11/16 |
| E | Amended plan following SAC Comment | 21/01/17 |
| F | ODR amendments | 19-05-17 |

SCALE AT A4: 1: 2500

0 20 40 60 80
 ALL DISTANCES ARE IN METRES

Figure 7

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7.3 LAND USE

The LSP proposes the development of the subject site for residential and open space purposes. Each are discussed in further details below.

7.3.1 Residential Land Use

Residential Density

The LSP specifies a range of residential densities, from R40 to R80. This level of density is identified to capitalise on the significant natural assets of the area, being the Canning River, Frye Park and vistas east towards the scarp. It also seeks to capitalise on the functional amenity of the Kelmscott District Centre and Train Station. The vast majority of the subject land is located within the nominal 800m walkable catchment of the Kelmscott Train Station and higher densities are accordingly warranted in accordance with Transit-Orientated Development principles. Furthermore, the densities proposed are consistent with the principles outlined in the City's draft Local Planning Strategy for areas in and around existing centres.

R40 is generally identified along the southern portion of Clifton St, to provide a suitable interface to the existing developed areas in the vicinity of the LSP. In the area south of Lucich St fronting the existing residential properties, this lower density, coupled with the two storey building height restriction, will combine to minimise the built form and visual impact of development in this location on existing residents and on the Clifton St streetscape.

R60 is identified for the majority of the LSP area. The south-western portions of existing Lots 23-26 are identified for R60 in order to capitalise on the amenity of the adjacent Canning River foreshore area. A density of R60 has been identified Lot 22, should the existing facility be redeveloped at some point in the future. R60 is identified for the majority of existing Lots 20 and 21, capitalising on close proximity to the Kelmscott Centre, the foreshore and Frye Park. R60 is considered an appropriate level of density in this area, given the quality and extent of the nearby functional and natural amenity.

A single R80 site is located at the western end of Lots 20 and 21, which seeks to maximise the benefit of this site's proximity to the existing centre and train station and its outlook over the river and foreshore area. The density coding allocated to this site reflects its proximity to amenity.

The proposed densities provide for a range of single, grouped and multiple dwellings to be developed within the LSP area. The LSP does not, however, mandate that a particular form of development (i.e. single, grouped and multiple dwellings) must occur in any particular location.

Residential Yield

Whilst the LSP does provide flexibility for different types of residential development, some assumptions have been made regarding the possible likely form of development that may occur in order to calculate a possible development yield for the LSP area. An indicative yield is outlined in **Table 9** below. It is emphasised that this yield is indicative and may change, should the assumptions underpinning the yield calculations change with the progression of detailed design.

| R-Coding | Site Area (m ²)* | Assumed Development Type | Lot Size (m ²) | Plot Ratio | Yield |
|-------------------------|------------------------------|--------------------------|----------------------------|------------|------------|
| <i>Lots 20 & 21</i> | | | | | |
| R60 | 10,170 | Multiple Dwellings | N/A | 0.7 | 109 |
| R80 | 2,822 | Multiple Dwellings | N/A | 1.0 | 43 |
| <i>Lot 22</i> | | | | | |
| R60 | 6,996 | Multiple Dwellings | N/A | 0.7 | 75 |
| <i>Lot 23</i> | | | | | |
| R40 | 1,444 | Grouped Dwellings | 220 | N/A | 6 |
| R60 | 2,223 | Multiple Dwellings | N/A | 0.7 | 23 |
| <i>Lot 24</i> | | | | | |
| R40 | 1,684 | Grouped Dwellings | 220 | N/A | 7 |
| R60 | 2,957 | Multiple Dwellings | N/A | 0.7 | 31 |
| <i>Lot 25</i> | | | | | |
| R40 | 1,684 | Grouped Dwellings | 220 | N/A | 7 |
| R60 | 3,394 | Multiple Dwellings | N/A | 0.7 | 36 |
| <i>Lot 26</i> | | | | | |
| R40 | 1,564 | Grouped Dwellings | 220 | N/A | 7 |
| R60 | 3,696 | Multiple Dwellings | N/A | 0.7 | 39 |
| Total | 38,712 | | | | 383 |

* Final areas subject to detailed design.

TABLE 9 – INDICATIVE YIELD CALCULATIONS

Different methodologies have been used to calculate the yield for the different anticipated types of development as follows:

- Grouped Dwelling sites – the yield has been calculated by dividing the total site area by the applicable average lot size and rounding down for each site.
- Multiple Dwelling sites – the yield has been calculated by multiplying the total site area by the applicable plot ratio, dividing by an assumed average apartment size of 65m² and rounding down for each site. This average apartment size is based on current housing market trends.

The indicative yield outlined in Table 9 is likely to represent the upper limit of new dwellings to be developed in the Clifton Street South Precinct. Some sites identified for multiple dwellings may instead be developed for grouped dwellings, with a lesser yield as a result. Similarly, market conditions at the time of development might dictate that development of a particular site may occur to a lesser density than that afforded to it by the LSP. Furthermore, detailed design may see additional areas provided onsite for common amenity areas (i.e. landscaping, swimming pools etc) that reduce the amount of land available for residential development and consequently result in a reduced yield.

This higher yield has been used as the basis for the traffic and servicing assessment of the impact of the proposed development on the LSP area. The use of this higher yield for these purposes provides confidence that development of this scale can occur without a negative impact on the surrounding areas from a technical perspective. It follows from this that development at a lesser scale can occur without further servicing or traffic requirements beyond those identified in **Sections 7.5 and 7.9**.

It is also noted that the calculations in Table 9 assume that development of Lot 22 will result in the provision of 75 residential dwellings (i.e. 19% of the calculated yield for the whole of the LSP area). The likelihood of redevelopment of this site and the timeframe within which it may occur is not considered a short-term prospect. As such, it may be several years before new dwellings are developed on this site that create a demand for services and generate additional vehicle traffic.

Gross & Site Density

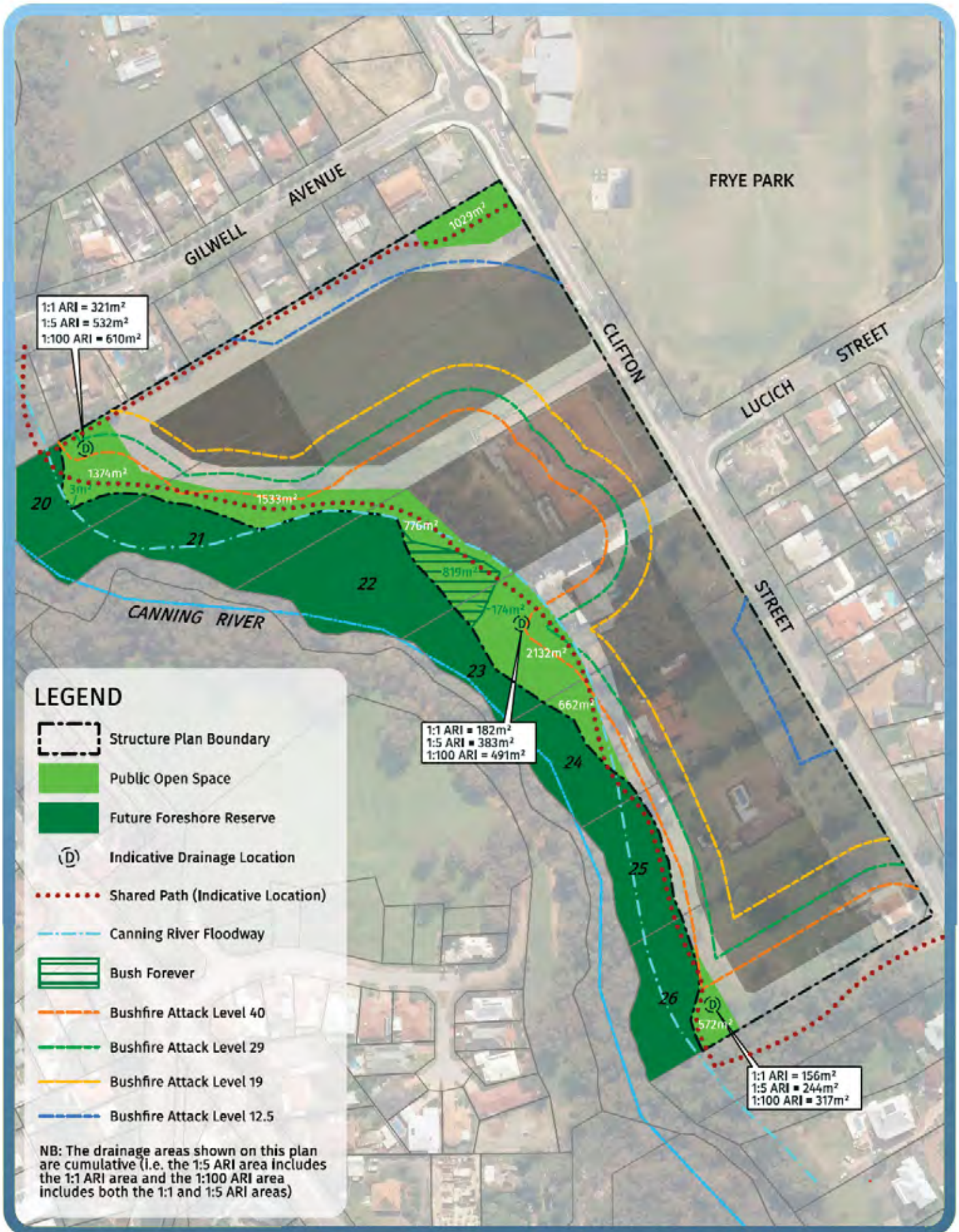
Based on the yield outlined in Table 9 and a total gross urban zoned area of 6.66ha, the estimated gross residential density is 58 dwellings/ha. The estimated residential density per site hectare, using the site area of 3.87ha, is 99 dwellings/ha.

Population

Assuming an occupancy rate of approximately 2 persons per dwelling (reflecting smaller dwelling sizes), the LSP could accommodate up to approximately 770 residents upon full development.

7.3.2 Open Space

A number of new public open space areas are proposed to be provided as part of the development of the LSP area, as depicted on **Figure 8**. These open space areas will serve a local drainage function and, combined with a new Canning River foreshore reserve, will provide new passive recreation opportunities and amenity and environmental benefits.



PUBLIC OPEN SPACE & DRAINAGE PLAN
 Clifton St South Precinct
 KELMSCOTT



| REV | DESCRIPTION | DATE | DRAWN | CHECKED | DRAWING No |
|-----|------------------|----------|--------------|-------------|---------------|
| C | Minor amendments | 08/10/16 | BDR 19-05-17 | JC 19-05-17 | 20176-09E.dgn |
| D | Amend ARI areas | 23/05/16 | | | |
| E | COA amendments | 19-05-17 | | | |

SCALE AT A4: 1: 2500

0 20 40 60 80

ALL DISTANCES ARE IN METRES

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NOTE:
 This plan has been prepared for planning purposes. Areas, Colours and Dimensions shown are subject to survey.



Figure 8



Proposed Public Open Space

The majority of new public open space is identified along the western boundary of the LSP area, abutting the future Canning River foreshore area. This area will accommodate the treatment and attenuation of local drainage associated with the development of the LSP area. The principle of locating open space in this location is generally in accordance with the position adopted by the City of Armadale in consideration and progressing Amendment No. 70 to TPS 4 (refer Section 2.1.2 and Figure 4).

All of the open space identified on Lots 23 and 24 and the majority of the open space identified on Lot 22 will accommodate the Canning River floodway. No development that requires filling, and hence changes the profile of the corridor, can occur within the floodway. As such, this area is undevelopable and can only reasonably be used for public open space. The extent of the floodway is located outside of the LSP boundary elsewhere in this area. Local drainage is proposed to be located within the floodway. The Department of Water (DoW) has confirmed the suitability of this approach.

The extent of the open space area abutting the future foreshore area on Lots 20 and 21 is based on direction provided by the current landowner (City of Armadale), with a preference to see a continuous open space linkage provided in this location. This linkage will provide the opportunity for further vegetation retention in this area and assist in limiting the impact of bushfire mitigation measures. A minimum width of 10m for this connection is depicted on the LSP, with the final width, form and function to be confirmed at the detailed design stage.

An area of Bush Forever is identified on Lots 22 and 23, with a very small portion identified at the western end of Lot 20. Both areas will be retained as open space. Other existing vegetation will be retained within the new public open space area, as well as existing vegetation within the future foreshore area.

A new small area of public open space is located at the southern end of the LSP, abutting the future foreshore area and future Martin St public open space area. This POS area has been located in this corner to accommodate local drainage associated with the southern catchment of the LSP. This area has been positioned in this corner to provide for a more regular public road alignment in this location.

It is envisaged that a new pedestrian and cyclist linkage will be provided along the length of the boundary of the LSP area, with the potential for it to meander through the future foreshore area, proposed local open space areas and abutting road reserves. The dual use path is envisaged to connect to Gilwell Avenue to the north and the future Martin St public open space area in the south as well as ultimately continuing north and south along the Canning River. An east-west pedestrian and cyclist linkage is also envisaged at the northern end of the LSP area within a new road reserve, connecting the Canning River foreshore area with Clifton St and facilities in Frye Park.

A new local open space area is identified on Lot 20 at the northern end of the LSP adjacent to Clifton St and opposite Frye Park. This open space area will facilitate the retention of the existing Frye Park production bore for ongoing use by the City of Armadale. This POS area will also facilitate

the retention of the existing mature trees located near the boundary of Lot 20. It is not envisaged that this local open space area will accommodate any local drainage. The extent of this open space area also provides the opportunity for the legal road access to be provided to the rear of Lot 21 (No. 53) Gilwell Avenue in the future.

Public Open Space Provision

The LSP has been prepared with due regard to the requirement of Liveable Neighbourhoods to provide a minimum of 10% of the nett site area as public open space. **Table 10** below documents the open space calculations for the LSP area and should be read in conjunction with Figure 8.

| | Gross Area (ha) | (ha) | (ha) |
|----------|--|--------|---------------|
| | Within Development Area 44 (Lots 20-26) | 6.6620 | |
| A | TOTAL | | 6.6620 |
| | Less Environmental Assets | | |
| | Bush Forever (Lots 20, 22-23) | 0.0996 | |
| B | TOTAL | | 0.0996 |
| C | NET SITE AREA (A – B = C) | | 6.5624 |
| | Deductions | | |
| | Dedicated Drainage Area (1yr) | 0.0659 | |
| D | TOTAL | | 0.0659 |
| E | Net Subdivisible Area (C – D = E) | | 6.4965 |
| F | 10% Requirement (10% of E = F) | | 0.6497 |
| | POS Requirement | | |
| G | <i>Minimum 80% Unrestricted POS (80% of F = G)</i> | 0.5197 | |
| H | <i>Maximum 20% Restricted Open Space (20% of F = H)</i> | 0.1299 | |
| | TOTAL | | 0.6497 |
| | POS PROVISION | | |
| | Unrestricted Open Space (Minimum 80% or 0.5226 ha) | | |
| | Northern Park | 0.1029 | |
| | Western Linear & Floodway Open Space (Excluding Bush Forever) | 0.6065 | |
| | Southern Park | 0.0484 | |
| I | SUB-TOTAL | | 0.7578 |
| | Restricted Open Space (Maximum 20% or 0.1304 ha) | | |
| | North-Western Drainage Area | 0.0211 | |
| | Floodway Drainage Area | 0.0201 | |
| | Southern Drainage Area | 0.0088 | |
| J | SUB-TOTAL | | 0.0500 |
| K | Credited Restricted Open Space (Maximum 20% or 0.1304 ha) | | 0.0500 |
| L | Total Credited POS (I + K) | | 0.8078 |
| M | Surplus POS (L – F = M) | | 0.1582 |
| | Percentage of POS Provided (L as % of E) | | 12.43% |

TABLE 10 – POS SCHEDULE

An overprovision of POS is identified on the LSP, which is largely a result of the linear open space connection provided along the southern boundaries of Lots 20 and 21 and the inclusion of the POS area located near Clifton St which will facilitate the retention of the existing production bore. If these areas were excluded from the calculations, then the amount of open space provided would marginally exceed the minimum 10% requirement. There is limited scope to modify the extent of the other open space area in the LSP area. The vast majority of the POS identified on Lots 22-24 is dictated by the extent of the Canning River Floodway and the areas identified at the north-western and south-eastern corners are needed for local drainage purposes.

It is anticipated that the extent, shape and position of these open space areas (excluding the floodway area) will be refined through the detailed subdivision process with further detailed technical drainage inputs. An updated POS Schedule is to be prepared and submitted with all applications for subdivision approval within the LSP area, demonstrating that a minimum of 10% open space is being provided. A condition of subdivision approval is also likely to be applied by the WAPC requiring the preparation and implementation of a Landscaping Plan for all open space areas to the satisfaction of the City.

Future Canning River Foreshore

The Canning River Foreshore area is located beyond the boundary of the LSP, but this feature represents a significant asset from which future residents of the LSP area will gain direct benefit. The extent of the Canning River Foreshore area abutting the LSP area is depicted on Plan 1. Remediation of the existing river environs will be required to accompany development of the LSP in support of the proposed densities.

Prior to any subdivision within the LSP area, a Foreshore Management Plan (the FMP) will need to be prepared for the whole of the area east of the existing Canning River channel up to the western boundary of the LSP and from Gilwell Avenue in the north to the northern edge of the existing Martin St road reserve in the south. The FMP shall address the following matters (but not limited to):

- Identification of useable, passive recreation spaces;
- Specification of extent and location of picnic, BBQ and other similar facilities;
- Identification of cyclist and pedestrian path requirements and specification of suitable alignment;
- Integration of the foreshore area with new areas of Local Open Space within the LSP;
- Consideration of possible pedestrian upgrades required at the existing Gilwell Ave bridge;
- Weed removal;
- Species planting and density;
- Tree retention;
- Foreshore area tenure; and
- FMP implementation and management requirements and responsibilities

It is anticipated that individual landowners/developers will subsequently be responsible for implementing the various elements of the FMP for the extent of the future foreshore area that abuts their proposed development.

7.4 BUILT FORM

It is envisaged that a high quality built form will be delivered in the development of the LSP area and it will be the expectation of the City that high quality outcomes are realised in order to fully achieve the development potential afforded by the nominated densities. Some key principles for the consideration of detailed built form design are as follows:

- The new built form should be contemporary in design, whilst also acknowledging and paying tribute to the architectural heritage of the Kelmscott locality.
- A mixture of dwellings types and sizes should be provided to facilitate dwelling ownership and occupation by a mixture of members of the community.
- New development shall orientate to the surrounding public realm (i.e. public roads and open space areas) to facilitate community interaction and passive surveillance.
- New built form shall provide for the creation of a varied and interesting streetscape, through articulation and the use of a mixture of materials and colours. Elevations may be articulated using some or all of the following measures: glazing, awnings, porticos, verandas, balconies, major openings to habitable rooms.
- Blank facades to the public realm should be avoided wherever possible.
- Bushfire mitigation requirements shall be incorporated into the built form in accordance with the requirements of the Bushfire Management Plan and AS 3959.

7.4.1 Local Development Plans

Local Development Plans (LDPs) will be required to be prepared and approved by the City of Armadale as a condition of subdivision approval and prior to the creation of new lots/development sites. LDPs shall specifically address open space, orientation and access matters for each new lot, as well as other relevant consideration outlined in Clause 6A.5.3 of TPS 4.

LDPs should be prepared with acknowledgment and due consideration provided to the following development principles:

- Vehicle access to laneway lots is to be provided from the rear laneway, with the dwelling orientating to and addressing the primary street;
- All dwellings shall have at least one major opening from a habitable room, outdoor living area and/or balcony facing all abutting public road reserves and/or public open space areas.
- All dwellings on lots/development sites directing abutting public open space areas shall be designed to orientate towards and provide surveillance of public open space areas.

- All dwellings should be provided with adequate solar access for outdoor living areas and habitable room windows.
- Visually permeable fencing shall be provided at the boundary between lots/development sites and public open space areas.
- All car parking areas (private residential and visitor) shall generally be located at the rear of a development site and/or lot and screened from view from the public realm.
- Some visitor parking may be able to be provided offsite within public road reserves, to the satisfaction of the City of Armadale.
- Vehicle access to lots/development sites shall preferably not be provided from Clifton St or from roads facing the Canning River.
- Specific built form measures required to mitigate potential bushfire hazards.

7.4.2 Minimum Building Height Requirements

The LSP incorporates a requirement for future built form on R60 and R80 coded sites to have a minimum height of two storeys to ensure that a minimum development standard is realised in the LSP area. This measure specifically seeks to avoid an outcome that results in single storey, single dwelling development at R60 and R80 densities, which would be contrary to the built form vision for the LSP area. A second level above the ground floor level must be provided to comply with the minimum building height requirement of the LSP. This is to be in the form of a full additional storey(s).

It is acknowledged that the existing Belrose River Gardens and Aged Care facility, which is identified as R60 on the LSP Map, is currently only developed as a single storey building. No change to the existing building is required under the LSP. Future development of and construction on the site, however, will be required to give due regard to the provisions of the LSP to the satisfaction of the City.

7.4.3 Maximum Building Height Limits

The LSP incorporates a two (2) storey height limit that applies to all forms (i.e. single, grouped and/or multiple) of new development fronting Clifton St, in the area generally located between Lucich St and Martin St. The calculation of this height limitation shall be undertaken in accordance with the requirements of the R-Codes.

This clause seeks to provide for a suitable built form interface between the LSP area and the existing properties located on the eastern side of Clifton St. Given the existing nature of the terrain in this area (i.e. rising eastwards), a two storey height limit will ensure that the mass and scale of new built form in this area will not dominate the streetscape and will not adversely affect the visual amenity of the existing property owners.

A maximum building height of three (3) storeys applies to all forms of development on land coded R60 and R80 within the LSP area.

7.4.4 Flood Fringe Development

A small portion of Lot 22 identified for R60 residential development is noted as being affected by the Canning River Floodway Fringe. The LSP requires that all habitable buildings constructed within the floodway fringe have a floor level at least 0.5m above the 1 in 100 year flood event so as to ensure that any permanent infrastructure and/or built form developed in this location is not adversely affected by major flood events. Should permanent structures be proposed in this location, then information will need to be provided at the LDP and/or Development Application stage to demonstrate that a suitable clearance to the flood level has been achieved.

7.5 MOVEMENT NETWORK

A Traffic Impact Assessment and supplementary Technical Note have been prepared in support of the LSP and both are included within **Appendix D**.

A series of new local road reserves are identified on the LSP, which will provide access to the new development sites and will provide public access between the Canning River foreshore area and Clifton St. The new roads will also provide a clear demarcation between the public and private realms, particularly along the foreshore and open space areas along the eastern boundary of the LSP.

The areas identified for new local roads on the LSP represent the minimum requirement considered necessary to enable development of the subject land. Additional roads and/or laneways may be provided where necessary, based on the proposed development strategy of an individual landowner/subdivider. The need for and suitability of additional road reserves will need to be demonstrated at the detailed subdivision design stage, to the satisfaction of the WAPC on the recommendation of the City. The inclusion of additional roads shall not require an amendment to the LSP, however, any additional roads and/or laneways shall be consistent with orderly and proper planning and not place an unreasonable burden on abutting landowners or compromise the intent of the LSP.

7.5.1 Road Widths

The ultimate reserve widths for new local roads and possible laneways within the LSP area will be determined at the detailed subdivision design stage, to the satisfaction of the WAPC on recommendation from the City of Armadale.

A series of assumptions regarding road reservation width have been in the preparation of the LSP. These are summarised as follows:

- Local Access Street – minimum 16m wide, with a 6m central carriageway and 5m wide verges on either side. The verge width is to accommodate the necessary servicing alignments, footpaths, street tree planting and on-street parking bays. A lesser width may be suitable, subject to the approval of the WAPC and City of Armadale, on the proviso that all cross section elements can be included. Lesser road reserve widths adjoining POS shall demonstrate that on-street parking, batters, footpaths, servicing and street tree planting can be contained within the overall reserve width.
- Laneway – 6m wide, in accordance with Liveable Neighbourhoods.

Suitable cross section designs should be discussed with the City of Armadale prior to lodgement of any subdivision applications.

7.5.2 Road Layout & Alignment

In determining the location of the new local roads, consideration has been given to the following items:

- Location of existing lot boundaries;
- Likely development timeframes and intentions of existing landowners;
- Interface with surrounding areas; and
- Principle of providing a public road interface between new private development and the Canning River foreshore and new public open space areas.

Northern Loop

Two sets of effectively loop roads are identified on the LSP. The northern loop road, on existing Lots 20 and 21, seeks to provide a suitable interface with the existing land uses to the north and south (Lot 22). Should the land located between the LSP area and Gilwell Avenue be rezoned at some point in the future, then the northern part of this new loop road would provide alternative legal road access to these properties with the likely requirement for new development to suitably orientate towards this new road. For the southern portion of this loop, it is anticipated that the existing Right of Carriageway over Lot 21 for the benefit of Lot 22 will be replaced with a dedicated and constructed road in this location that provides suitable access to Lot 22. A reduced road reserve width may be possible (subject to approval of the WAPC and the City) where this road abuts public open space.

The acute bend on Lot 20 adjacent to POS is subject to further detailed design, and may require modification. Future subdividers of Lot 20 will need to demonstrate that the proposed bend will provide a safe vehicle turning path, to the satisfaction of the City.

Southern Loop

The southern loop features a reduced road reserve width along the eastern boundary of the LSP and abutting the new areas of public open space within the LSP. A reduced road reserve width may be possible for the southern boundary of Lot 26 to link the foreshore boundary road with Clifton St. A full width road reserve is envisaged along the northern boundary of Lot 23, given the likely development on both sides of this road.

Possible Additional East-West Road

An additional east-west road is notionally identified on the Concept Masterplan on the common boundary of Lots 24 and 25. A road in this location is not essential for traffic movement purposes, given the small scale of this southern development cell. A possible road is, however, identified in this location on the Concept Master Plan only should Lots 24 and/or 25 be developed in advance of Lots 23 and 26. The provision of a road in this location will enable access to the foreshore to be provided independent of the development of Lot 23 and/or 26.

This possible road could be located equally on Lots 24 and 25 if developed together or partially or wholly on either if a single lot is developed prior to the other. Arrangements for the sharing of costs associated with the development of this road should be negotiated between the owners of these lots at the time of subdivision and development.

Should development of Lots 24 and 25 occur after the development of either of Lots 23 or 26, then this potential road is unlikely to be required. Similarly, if all of Lots 23 to 26 were to be developed simultaneously, then this road is not likely to be needed. Under these scenarios, a landowner or developer may still opt to construct an east-west road on or in the vicinity of the common boundary of Lot 24 and 25 for building design and access reasons.

Lot 22

No new roads are identified on Lot 22. A linkage has not been provided in this location for the following reasons:

- It is not anticipated that this site will be redeveloped in the short to medium term and there is therefore no guarantee that any linkages between Lots 21 and 23 within the LSP area will be realised.
- It is not essential for vehicle circulation purposes, due to the low volumes of traffic that will be generated by the development of the LSP area.
- Each loop will perform a local traffic function only and a linkage will not provide a connection to the wider district movement network.
- Not providing a connection in this location avoids the creation of an approximately 450m singled sided long road that might attract anti-social vehicle behaviour.

Notwithstanding the fact that a road linkage has not been identified on the LSP, a connection may be provided between Lot 21 and 23 if so desired by the landowner if redevelopment occurs, subject to the approval of the City and WAPC.

7.5.3 Intersections

Details associated with the design of any required intersection treatments, including any new and upgraded local road connections to the primary road network will be identified and concept designs will be prepared during the detailed subdivision stages of the development, in consultation with the City of Armadale. The City may require future developers or subdividers to investigate the need for any modifications or upgrades to existing traffic management devices in the abutting Clifton Street reserve. If lot design or development form requires, such traffic management devices may need to be upgraded or modified. Such investigations/upgrades may include the existing intersection of Gilwell Avenue and Martin Street given its proximity to LSP area. It is noted that the former intersection has been the subject of recent upgrade works.

All intersection within the LSP area will be basic priority-controlled T-intersections, due to the relatively low traffic volumes. Local intersection connections with Clifton Street are proposed to typically operate under T-intersection Give Way control. The City's Technical Services have advised that two full movement intersections to Clifton Street will be permitted for the LSP area. The remainder of the intersections are required to be left-in/left-out only.

The proposed intersections with Clifton Street in the vicinity of both the existing Lucich Street and Martin Street intersections are sufficiently offset to satisfy *Austroads Guide to Traffic Engineering Practice: Part 4A – Road Design* requirements, which recommends a minimum 8 to 15m offset stagger (in a left-right arrangement). The expected conflict between the inbound right-turning movements at these intersections is expected to be low due to the expected low volumes turning into and out of the local road connections during peak periods. A review of the crash history also indicates a very low rate of side swipes or right-angle crashes along Clifton Street.

7.5.4 Pedestrians & Cyclists

A new shared pedestrian and cyclist path is to be provided along the western boundary of the LSP area and along the future Canning River foreshore area, as noted in Section 7.1.2. The alignment of this path will be determined in the preparation of a Foreshore Management Plan for the Canning River area, with the likelihood that it will meander through new local open space and future foreshore areas. This pathway will play an important role in connecting the LSP area with the Kelmscott District Centre and railway station, via the Gilwell Avenue bridge, and will have a minimum width of 2.5m

New east-west shared path connections are also identified at the northern end of the LSP and within the future Martin St local open space area to the south of the LSP. In addition, new local access streets within the LSP will be constructed with footpaths (minimum width of 1.5m) on at least one side to facilitate and encourage walking.

7.6 WATER MANAGEMENT

A Local Water Management Strategy (LWMS) has been prepared by Bayley Environmental Services, in collaboration with Shawmac Consulting Engineers, and is included at **Appendix C**. The LWMS has been approved by the Department of Water and outlines the key water use sustainability measures for public open space areas and within new private dwellings and developments. Further key elements of the LWMS Report are included below.

7.6.1 Stormwater Drainage Management System

The drainage system will be designed to maintain surface flow rates and volumes within and from the LSP at or below their pre-development levels. A total of three drainage catchments are identified.

The runoff from building roofs will be conveyed via a dedicated pipe system with inlet points on each lot, discharging to detention basins located on the western side of each catchment and overflowing into the Canning River. Roof runoff is expected to make up to 90% of the total runoff from lots. Runoff from paths, driveways and other paved areas within lots will be partly captured by garden beds and lawns, with larger flows overflowing into the road drainage system.

Runoff will travel via the piped minor flow system (up to 5-year ARI) or by a combination of piped and pavement flow (5-year to 100-year ARI) into the detention basins located in POS on the western side of each catchment. From these basins, the water will be released at a controlled rate (not exceeding the pre-existing peak flow rate) into the Canning River.

The existing drain within the easement on Lot 22 will remain in place until such time as Lot 22 is redeveloped in accordance with the LSP. At that time, the drainage design for Lot 22 will need to take account of the flows in the existing drain.

7.6.2 Groundwater

The development of the LSP area will have no significant effect on groundwater levels beneath the subject area. Bore sampling undertaken to date indicates that the groundwater beneath the site is generally of high quality, containing low concentrations of nitrogen, phosphorus and other contaminants. Development of the site is not expected to significantly change the quality of groundwater beneath the site. The main threats to water quality under urban development are lawn and garden fertilisers and road runoff. The contaminant of main concern is phosphorus. The density of the proposed development means that lawn and garden areas will be limited.

7.6.3 Landscaping Strategy

The landscaping of the site will focus on the use of low water demand species and unirrigated grass. Irrigation of street trees will be limited to the first two summers after establishment. Irrigated turf will be limited to the central amenity areas of POS. Further details of water and nutrient management will be provided in Landscape Plans that are to be prepared prior to subdivision implementation.

7.7 BUSHFIRE MANAGEMENT

A series of Bushfire Attack Levels (BAL) are identified on **Figure 8**, reflecting the outcomes of the bushfire hazard risk assessment undertaken and incorporated in the BMP included within **Appendix B**. There are different construction requirements to mitigate against fire risk for the different BAL ratings, which are outlined in AS 3959-2009 *Construction of buildings in bushfire prone areas*. The BMP has been endorsed by DFES.

7.8 ACTIVITY CENTRES AND EMPLOYMENT

No additional land is proposed to be developed for retail, commercial, industrial or other employment-generating uses within the LSP area. The close proximity of the subject site to the existing Kelmscott District Centre to the west and the Armadale City Centre further south provide excellent opportunities for people to live and work locally.

7.9 SERVICING & STAGING

A Servicing Report has been prepared by Shawmac Consulting Engineers and is included within **Appendix E**. The key elements of the Servicing Report are included below.

7.9.1 Water

There is an existing 205mm steel pipe and 100mm cast iron pipe running along Gilwell Avenue as well as a 400mm steel pipe and a 100mm cast iron pipe running along Lucich Street and then south along Clifton Street. The Water Corporation has confirmed that there is sufficient capacity within the existing network to service the proposed development.

7.9.2 Sewer

The Water Corporation has confirmed that the sewer network will need to gravitate to the existing Pump Station No.4 at the end of River Road to the west of the subject land and on the western side of the Canning River. As such, the sewer infrastructure will need to cross the Canning River.

Water Corporation sewer planning identifies a possible future proposed gravity sewer, starting from behind existing Lot 525 (near the Lucich and Charles Street intersection) and running down between Lots 23 and 24 and across the Canning River to Pump Station No.4 on River Road. It is not yet known if/when this sewer line will be installed.

If this identified future proposed sewer line has not been installed at the time of commencement of development of the LSP area, then a connection will need to be provided across the Canning River and into Pump Station No. 4. If the future proposed sewer line has already been installed, then the sewer for the LSP area may be able to connect into the existing infrastructure (if approved by Water Corporation) and therefore will not require an additional crossing over the river and into the pump station. Specific sewer requirements will be confirmed at the subdivision stage, based on the extent of infrastructure in place at that time and the staging of development.

7.9.3 Power

Western Power have confirmed that there is a 22kV network (G522 85 Wheatley St feeder) running along Clifton St with sufficient capacity to service the development of the LSP area, with connection via 185mm² or 400mm² Al XLPE 22kV cables. It is not likely that reinforcement works on the existing network will be required for this connection (pending development timing).

7.9.4 Gas

A medium pressure gas main runs along the western side of Clifton Street. Atco Gas has confirmed that the medium pressure gas main has the capability to service an additional 2,000 dwellings, which is sufficient for the proposed development. No pressure reduction infrastructure is required to provide a suitable reticulated gas service to the new development.

7.9.5 Telecommunications

The National Broadband Network (NBN) has not been rolled out in the area and there is no time frame for installation of NBN services in the vicinity of the LSP area. It is noted that NBN Co will install new cable in developer provided pit and pipe where the development exceeds 100 lots. If NBN Co are unable to install the NBN infrastructure, then Telstra will provide the service. In the interim, before connection to the NBN, access to the existing telecommunications infrastructure running along Clifton Street will provide adequate telecommunications to the proposed development.

7.9.6 Existing Bore Infrastructure

Part 1 of the LSP requires that suitable arrangements be made with the City regarding the relocation of the existing underground 240V bore supply and mainline that runs east-west through Lot 20 to future road and/or open space reserves. Relocation works are intended to occur as part of the subdivision implementation process in order to ensure that the City's existing bore infrastructure can continue to be utilised for its current purpose.

7.9.7 Staging

Given the fragmented nature of the existing landholdings within the LSP area, it is not possible to specify the likely staging of subdivision and development. It is envisaged that subdivision and development will occur progressively, with landowners/developers required to provide the necessary services to facilitate the development of their parcels.

The design and implementation of services (i.e. alignments, levels) and earthwork levels for the initial stages of development is to be done in such a way so as to enable the efficient and effective co-ordination of subsequent stages with the initially installed servicing and drainage infrastructure.

7.10 DEVELOPER CONTRIBUTION ARRANGEMENTS

Developer Contribution Arrangements (DCA) are not proposed to be established for the LSP area. It will be the requirement of each subdivider to construct new local roads identified to service the development of their landholdings and to provide open space as identified on the LSP Map. The LSP layout provides for the largely equitable distribution of open space and land for new public roads across existing landownership boundaries. The establishment and operation of formal DCA is not considered appropriate for a relatively small scale development such as this, given the additional cost imposed for landowners to prepare a Developer Contribution Plan (DCP) and the ongoing DCP maintenance obligation placed on the City of Armadale to administer the arrangements.

8 CONCLUSION

This LSP has been prepared to outline a land use and movement network framework for the development of Lots 20-26 Clifton Street, Kelmscott to accommodate medium and high density residential housing and open space. The LSP encourages the development of higher density residential facilities that seek to capitalise on the existing natural and functional amenity that is located within close proximity to the site.

The LSP seeks to stipulate the key boundaries between land uses, address the key interface considerations and identify the key matters that need to be addressed at the detailed subdivision and development stages. This LSP therefore affords a certain degree of flexibility for innovative and creative detailed design responses, provided that there is compliance with the key elements and principles of the LSP and that the key objectives are realised.

APPENDIX A

Certificates of Title & Sketches

WESTERN



AUSTRALIA

| | |
|---------------------------------------|-------------------------------------|
| REGISTER NUMBER 20/DP222705 | |
| DUPLICATE FOOTNOTES N/A | DATE DUPLICATE ISSUED N/A |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1274FOLIO
808

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

**LAND DESCRIPTION:**

LOT 20 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

TOWN OF ARMADALE OF JULL STREET, ARMADALE

(T B859383) REGISTERED 6 FEBRUARY 1980

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1274-808 (20/DP222705).
PREVIOUS TITLE: 1234-426.
PROPERTY STREET ADDRESS: 77 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 20 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 20 ON DEPOSITED PLAN 222705 ON 26-APR-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

WESTERN



AUSTRALIA

| | |
|---------------------------------------|---|
| REGISTER NUMBER 21/DP222705 | |
| DUPLICATE NUMBER 1 | DATE DUPLICATE ISSUED 24/1/2003 |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1447FOLIO
992

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.


REGISTRAR OF TITLES
**LAND DESCRIPTION:**

LOT 21 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

TOWN OF ARMADALE OF 7 ORCHARD AVENUE, ARMADALE
(T C440017) REGISTERED 19 OCTOBER 1982

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. 1342918 EASEMENT BURDEN REGISTERED 2.1.2003.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
1 of as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1447-992 (21/DP222705).
PREVIOUS TITLE: 1253-662.
PROPERTY STREET ADDRESS: 79 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

NOTE 1. A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 21 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 21 ON DEPOSITED PLAN 222705 ON 09-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2. THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

WESTERN



AUSTRALIA

| | |
|---------------------------------------|---|
| REGISTER NUMBER 22/DP222705 | |
| DUPLICATE EDITION 6 | DATE DUPLICATE ISSUED 28/9/2016 |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1455 FOLIO 716

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 22 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MERCY HUMAN SERVICES LIMITED OF 38 ORD STREET WEST PERTH WA 6005

(T N444089) REGISTERED 27/9/2016

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. H289484 EASEMENT TO CITY OF ARMADALE. SEE SKETCH ON VOL. 1455 FOL. 716. REGISTERED 24/11/1999.
2. H289483 RESTRICTIVE COVENANT TO CITY OF ARMADALE. REGISTERED 24/11/1999.
3. I342918 EASEMENT BENEFIT REGISTERED 2/1/2003.
4. *N488749 MORTGAGE TO COMMONWEALTH BANK OF AUSTRALIA REGISTERED 21/11/2016.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1455-716 (22/DP222705)
PREVIOUS TITLE: 1447-993
PROPERTY STREET ADDRESS: 89 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AUTHORITY: CITY OF ARMADALE

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING N488749

WESTERN



AUSTRALIA

REGISTER NUMBER
23/DP222705

DUPLICATE
NUMBER
2

DATE DUPLICATE ISSUED
8/1/2009

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1447

FOLIO
994

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES



LAND DESCRIPTION:

LOT 23 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MALCOLM JOHN SELLS OF 91 CLIFTON STREET, KELMSCOTT
(T K787480) REGISTERED 23 DECEMBER 2008

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1447-994 (23/DP222705).
PREVIOUS TITLE: 1253-662.
PROPERTY STREET ADDRESS: 91 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 23 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 23 ON DEPOSITED PLAN 222705 ON 09-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

WESTERN



AUSTRALIA

| | |
|---------------------------------------|---|
| REGISTER NUMBER 24/DP222705 | |
| DUPLICATE NUMBER 1 | DATE DUPLICATE ISSUED 17/5/2004 |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1434

FOLIO
865

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.


REGISTRAR OF TITLES 

LAND DESCRIPTION:

LOT 24 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

JUDITH ANN BUGGINS
RICHARD CLIVE BUGGINS
BOTH OF 99 CLIFTON STREET, KELMSCOTT
AS JOINT TENANTS

(T M108306) REGISTERED 20 NOVEMBER 2012

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *M108307 MORTGAGE TO COMMONWEALTH BANK OF AUSTRALIA REGISTERED 20.11.2012.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1434-865 (24/DP222705)
PREVIOUS TITLE: 1253-662,
PROPERTY STREET ADDRESS: 99 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

- NOTE 1. A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 24 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 24 ON DEPOSITED PLAN 222705 ON 09-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.
- NOTE 2. THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.
- NOTE 3. DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING

END OF PAGE 1 - CONTINUED OVER

RECORD OF CERTIFICATE OF TITLE

REGISTER NUMBER: 24/DP222705

VOLUME/FOLIO: 1434-865

PAGE 2

J804594



WESTERN



AUSTRALIA

| | |
|---------------------------------------|--|
| REGISTER NUMBER 25/DP222705 | |
| DUPLICATE NUMBER 1 | DATE DUPLICATE ISSUED 6/4/2005 |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1447FOLIO
995

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.



REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 25 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

GEOFFREY GORDON MORFITT
SHARON ANNE MORFITT
BOTH OF 107 CLIFTON STREET, KELMSCOTT
AS JOINT TENANTS

(T J215720) REGISTERED 16 MARCH 2005

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1447-995 (25/DP222705).
PREVIOUS TITLE: 1253-662.
PROPERTY STREET ADDRESS: 107 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 25 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 25 ON DEPOSITED PLAN 222705 ON 09-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

WESTERN



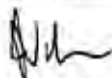
AUSTRALIA

| | |
|---------------------------------------|---|
| REGISTER NUMBER 26/DP222705 | |
| DUPLICATE NUMBER 1 | DATE DUPLICATE ISSUED 19/7/2012 |

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
1447FOLIO
996

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.


 REGISTRAR OF TITLES

**LAND DESCRIPTION:**

LOT 26 ON DEPOSITED PLAN 222705

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ANNE ELIZABETH GRAYDEN OF 111 CLIFTON STREET, KELMSCOTT
(T C784247) REGISTERED 1 JUNE 1984

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1447-996 (26/DP222705).
PREVIOUS TITLE: 1253-662.
PROPERTY STREET ADDRESS: 111 CLIFTON ST, KELMSCOTT.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.

NOTE 1 A000001A LAND PARCEL IDENTIFIER OF KELMSCOTT TOWN LOT/LOT 26 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 26 ON DEPOSITED PLAN 222705 ON 09-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2 THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

DP 222705
KELMSCOTT 20/8

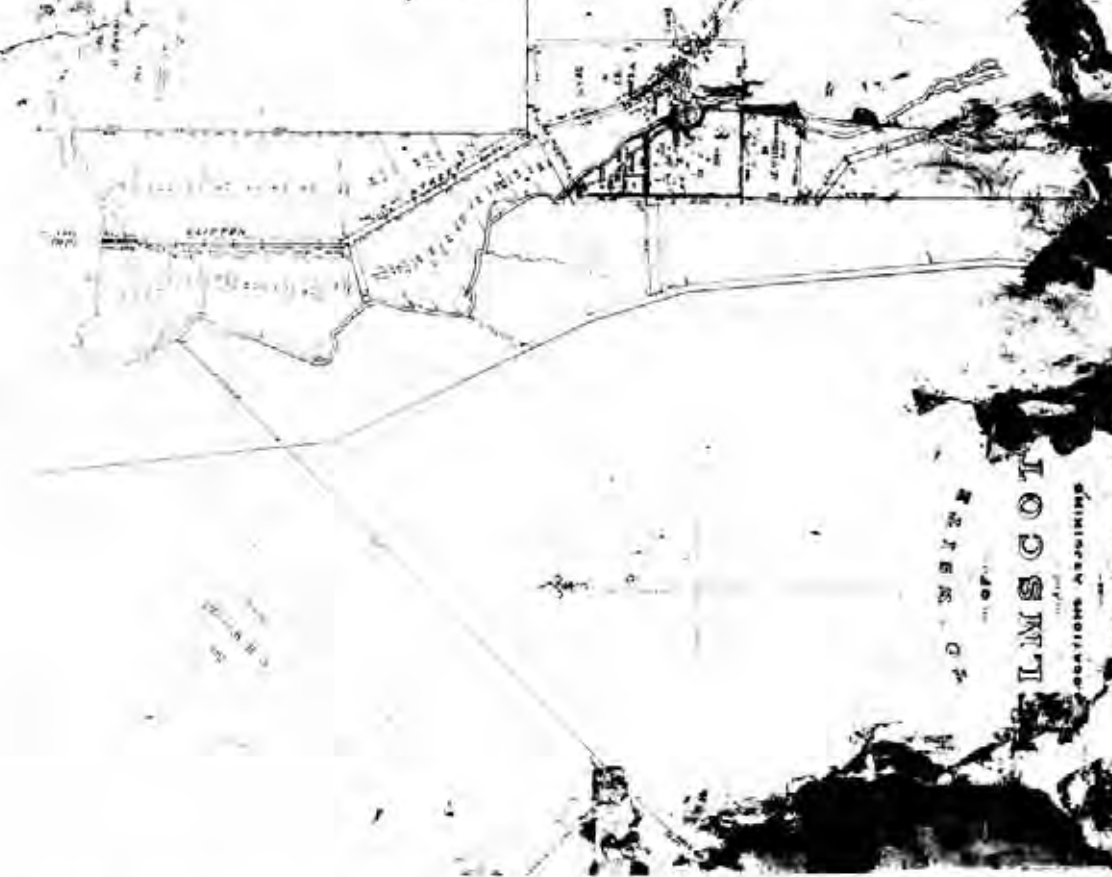
KELMSCOTT 20/8

20
KELMSCOTT 20/8

REPLACEMENT PLAN
This document is approved in respect of the replacement plan for the Kelmscott 20/8. It is a replacement plan and does not constitute a development application. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006.

REPLACEMENT PLAN
This document is approved in respect of the replacement plan for the Kelmscott 20/8. It is a replacement plan and does not constitute a development application. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006. It is subject to the provisions of the Planning and Development Act 2005 and the Planning and Development Regulations 2006.

| Lot | Area (sqm) | Use | Notes |
|-----|------------|-------------|-------|
| 1 | 1000 | Residential | |
| 2 | 1000 | Residential | |
| 3 | 1000 | Residential | |
| 4 | 1000 | Residential | |
| 5 | 1000 | Residential | |
| 6 | 1000 | Residential | |
| 7 | 1000 | Residential | |
| 8 | 1000 | Residential | |
| 9 | 1000 | Residential | |
| 10 | 1000 | Residential | |
| 11 | 1000 | Residential | |
| 12 | 1000 | Residential | |
| 13 | 1000 | Residential | |
| 14 | 1000 | Residential | |
| 15 | 1000 | Residential | |
| 16 | 1000 | Residential | |
| 17 | 1000 | Residential | |
| 18 | 1000 | Residential | |
| 19 | 1000 | Residential | |
| 20 | 1000 | Residential | |



20/8
KELMSCOTT
REPLACEMENT PLAN

APPENDIX B

Bushfire Management Plan & DFES Approval RUIC Fire

The Bushfire Management Plan was approved by DFES in advance of the approval of the Local Structure Plan by the WAPC. Minor modifications to the LSP layout were required by the WAPC which are inconsequential to the bushfire management strategies and requirements outlined in the approved BMP. Further bushfire reporting will be required at the subsequent stages in the planning and development process and the minor modifications to the LSP layout are to be incorporated as part of this subsequent reporting.



Our Ref: D00966
Your Ref:

Meredith Kenny
City of Armadale
7 Orchard Avenue
ARMADALE WA 6112
MKenny@armadale.wa.gov.au

Dear Meredith

**LOTS 20-26 CLIFTON STREET KELMSCOTT - CANNING RIVER CLIFTON STREET
PRECINCT (SOUTH) STRUCTURE PLAN – BMP V1.2**

I refer to an email from Jason Carr from Harley Dykstra dated 13 February 2017 regarding the submission of a revised Bushfire Management Plan (BMP) Version 1.2 by RUIC Pty. Ltd. dated 11 February 2017 submitted for the above structure plan.

The Department of Fire and Emergency Services (DFES) provide the following comments with regard to *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) and the *Guidelines for Planning in Bushfire Prone Areas* (Guidelines):

DFES advises that the proponent has adequately identified issues arising from the bushfire attack level contour map and considered how compliance with the bushfire protection criteria can be achieved at subsequent stages of the planning process within the submitted BMP.

Should you require further information, please contact me on telephone number 9482 1761.

Yours sincerely

Sandeep Shankar
LAND USE PLANNING OFFICER

28 March 2017

cc Gary.McGowan@planning.wa.gov.au
JasonC@HarleyDykstra.com.au

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address:

Site visit: Yes No

Date of site visit (if applicable): Day Month Year

Report author:

WA BPAD accreditation level (please circle):

Not accredited Level 1 BAL assessor Level 2 practitioner Level 3 practitioner

If accredited please provide the following.

BPAD accreditation number: Accreditation expiry: Month Year

Bushfire management plan version number:

Bushfire management plan date: Day Month Year

Client/business name:

| | Yes | No |
|--|-------------------------------------|-------------------------------------|
| Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)? | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

Is the proposal any of the following (see [SPP 3.7 \(or definitions\)](#))?

| | Yes | No |
|---|-------------------------------------|-------------------------------------|
| Unavoidable development (in BAL-40 or BAL-FZ) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Strategic planning proposal (including rezoning applications) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| Minor development (in BAL-40 or BAL-FZ) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| High risk land-use | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Vulnerable land-use | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

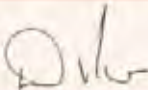
None of the above

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author



Date



BUSHFIRE MANAGEMENT PLAN

Strategic Planning Proposal (Local Structure Plan)

Lots 20-26 Clifton St, Kelmscott

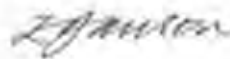
Version: 1.2 Reference: 5580 February 2017



Project Number: 5580
Project Name: LSP, Lots 20-26 Clifton St, Kelmscott
Author: Darrel Krammer, Grad Cert Bushfire Protection, BPAD33412, Level 1
Approved by: Erika Dawson, Grad Dip Bushfire Protection, BPAD 363/1, Level 3
Version: 1.2
Date of issue: 11th February 2017



Author:
Date: 11/02/2017



Approved by:
Date: 11/02/2017

In the signing the above, the author declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7. This report supersedes all previous Bushfire Management Plans for the site.

DISCLAIMER AND LIMITATION

This report is prepared solely for **Harley Dykstra** (the 'proponent') and any future landowners of the subject lot(s) and is not for the benefit of any other person and may not be relied upon by any other person.

The mitigation strategies contained in this Bushfire Management Plan are considered to be prudent minimum standards only, based on the writer's experience as well as standards prescribed by relevant authorities. It is expressly stated that RUIC Fire and the writer do not guarantee that if such standards are complied with or if a property owner exercises prudence, that a building or property will not be damaged or that lives will not be lost in a bush fire.

Fire is an extremely unpredictable force of nature. Changing climatic factors (whether predictable or otherwise) either before or at the time of a fire can also significantly affect the nature of a fire and in a bushfire prone area it is not possible to completely guard against bushfire.

Further, the growth, planting or removal of vegetation; poor maintenance of any fire prevention measures; addition of structures not included in this report; or other activity can and will change the bushfire threat to all properties detailed in the report. Further, the achievement of the level of implementation of fire precautions will depend on the actions of the landowner or occupiers of the land, over which RUIC Fire has no control. If the proponent becomes concerned about changing factors then a new Fire Risk Management Plan should be requested.

To the maximum extent permitted by the law, RUIC Fire, its employees, officers, agents and the writer ("RUIC Fire") excludes all liability whatsoever for:

1. claim, damage, loss or injury to any property and any person caused by fire or as a result of fire or indeed howsoever caused;
2. errors or omissions in this report except where grossly negligent; and

the proponent expressly acknowledges that they have been made aware of this exclusion and that such exclusion of liability is reasonable in all the circumstances.

If despite the provisions of the above disclaimer RUIC Fire is found liable then RUIC Fire limits its liability to the lesser of the maximum extent permitted by the law and the proceeds paid out by RUIC Fire's professional or public liability insurance following the making of a successful claim against such insurer.

RUIC Fire accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report and its supporting material by any third party.

This report is valid for a period of three years only from the date of its issue. All BAL ratings identified in this report are indicative and are required to be verified at the time of construction of individual buildings to ensure appropriate setbacks identified in the proposed development have been achieved.

RUIC Fire is a trading name of

Rural Fire Risk Consultancy Pty Ltd

ABN: 48 151 451 713

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1.0 Introduction

1.1 Subject Site

The site the subject of this Bushfire Management Plan (BMP) is Lots 20 to 26 Clifton St, Kelmscott.

The site is located within the municipality of the City of Armadale (CoA). Figures 1A-1E illustrates the subject site and its immediate surrounds, and the proposed Local Structure Plan (LSP) options. The site is located to the east of Canning River and Bush Forever site 246, which consists of the river and foreshore.

The current lots are identified for urban development, with a future foreshore reserve to be established along the Canning River on their south western boundary.

The Canning River and its floodplain reserve running approximately north-south on the western boundary of the lots is the main area of vegetation through the landscape. The subdivision and development guided by the LSP will provide the foreshore reserve land with appropriate tenure allowing for management by the CoA to protect the Canning River and its riparian and fringing vegetation. The Canning River Foreshore Parkland will be implemented in stages to provide new opportunities for local passive recreation in a natural setting. The CoA will subsequently conduct design and management studies for the foreshore and parkland areas with the aid of community and public review input.

The site is identified as being Bushfire Prone on the State Bushfire Prone Maps.

Prior to any subdivision occurring within the LSP area, the following conditions are to be met to the satisfaction of the CoA:

- Preparation and implementation of a Landscaping Plan as a condition of subdivision approval for all open space areas to the satisfaction of the CoA;
- A Foreshore Management Plan (the FMP) will need to be prepared for the whole of the area east of the existing Canning River channel up to the western boundary of the LSP area and from Gilwell Avenue in the north to the northern edge of the existing Martin St road reserve in the south. The FMP shall address the following matters (but not limited to):
 - Identification of useable, passive recreation spaces;
 - Specification of extent and location of picnic, BBQ and other similar facilities;
 - Identification of cyclist and pedestrian path requirements and specification of suitable alignment;
 - Integration of the foreshore area with new areas of Local Open Space within the LSP;
 - Consideration of possible pedestrian upgrades required at the existing Gilwell Ave bridge;
 - Weed removal;
 - Species planting and density;
 - Tree retention;
 - Foreshore area tenure; and
 - FMP implementation and management requirements and responsibilities.
- Update to this BMP, identifying proposed subdivision and revised BAL Contour Map, identification of any bushfire hazard issues and compliance with the bushfire protection criteria.

The proponent has not identified any other relevant environmental considerations (wellands, foreshores, Bush Forever sites, remnant vegetation, threatened species, ecological communities, nature reserves or coastal reserves) within the site or being affected by the development.

1.2 Development Description

This strategic BMP has been developed to support the proposed LSP for the development of Lots 20-26 Clifton Street, Kelmscott to accommodate medium and high density residential housing and open space.

Two proposals have been presented to demonstrate compliance, the first being the ultimate LSP design, whereby Lot 22 Clifton St is further developed to remove vegetation located within the south west portion of the lot. The second option demonstrates compliance should Lot 22 development not occur.

1.3 Previous Bushfire Assessments

Two previous Bushfire Management Plans have been prepared by Ecosystem Solutions, dated October 2015 and August 2016.

DFLS have provided comment on the original BMP by way of a Land Use Planning Referral dated 23 June 2016.

This BMP serves to provide up to date site and planning information in accordance with SPP3.7.



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

Site Overview - no Plot 12

- Site Boundary
- Cadastre
- Main Road



Size: A4
 Scale: 1:3,500



Ref: 5567_001_R2_BaseMap_20170223
 Projection: GDA94 MGRS50
 Author: MM - RUIC | Date: 2017-02-08
 Data Source: Cadastre - cadastral boundary -
 Heatmap Road, Site Boundary, Veq. EAL Buffer -
 MM - RUIC

Disclaimer: Although the data within this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within the map.

Figure 1A: Site Overview (Development Occurs within Lot 22 Clifton St)



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

Site Overview - with Plot 12

Site Boundary

Cadastre

Main Road



Size: A4
 Scale: 1:3,500



Ref: 589_001_03_BaseMap_20170216
 Projector: GCS/Australian
 Author: MM - RUIC | Date: 201702-08
 Data Source: Cadastre - (aerial imagery -
 Hepburn Road, Site Boundary, Irida, BFL, Buffer,
 RMF - RUIC

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Figure 1B: Site Overview (Development DOES NOT occur within Lot 22 Clifton St)

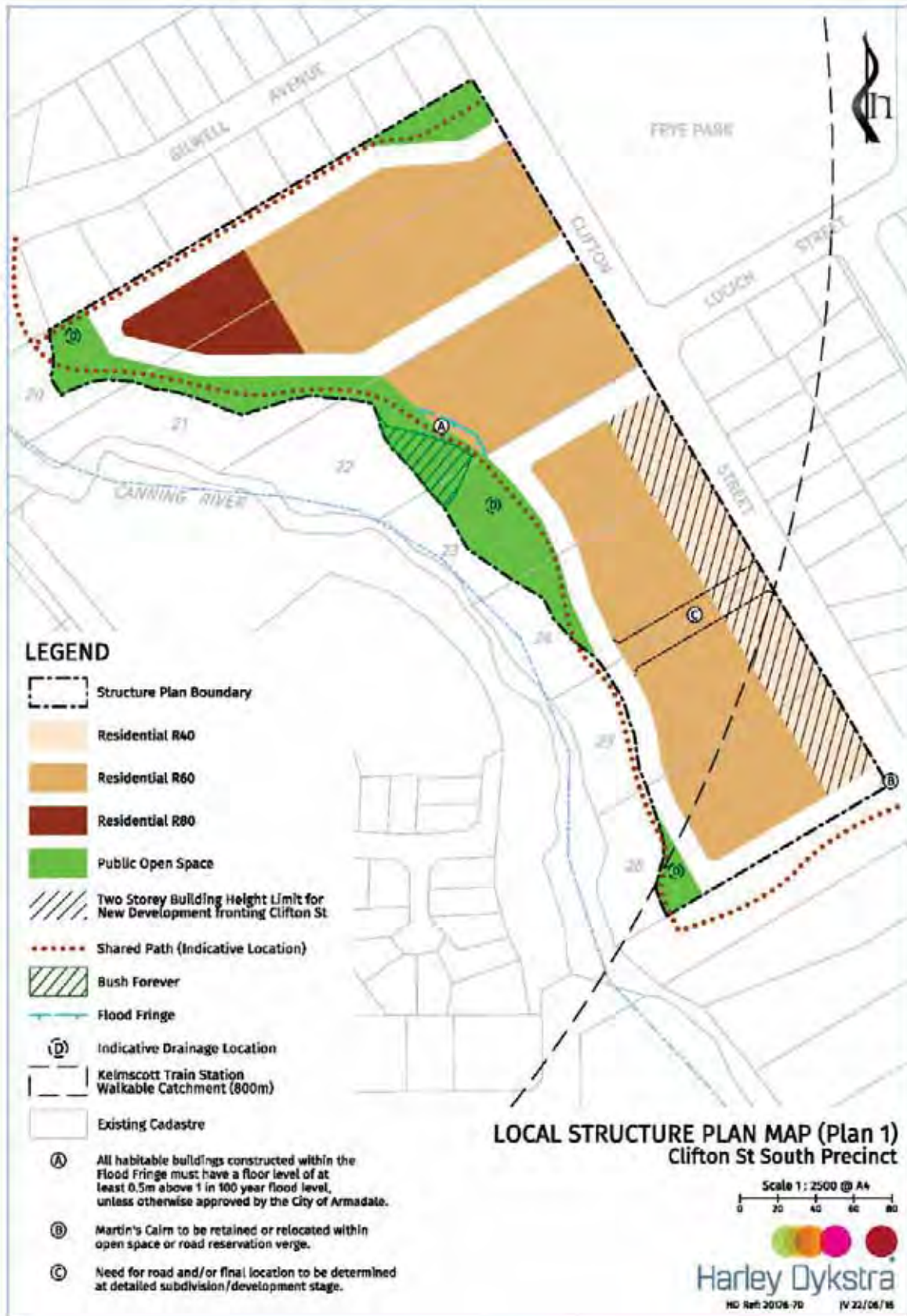


Figure 1C: LSP Map (Client 2016)



CONCEPT MASTERPLAN
 Clifton St South Precinct

Harley Dykstra
 SURVEY & CIVIL ENGINEERING

| | | |
|-----------------------|------------------------|-----------------------------|
| DRAWN RUS 14/11/16 | CHECKED S. 14/11/16 | DRAWING NO. 2016-082-010 |
| DATE 14/11/16 | SCALE AS SHOWN | SCALE AT AN 1:2500 |

ALL DIMENSIONS ARE IN METRES

Figure 7

1. This drawing is a conceptual plan only and does not constitute a contract. It is for illustrative purposes only and is subject to change without notice. It is not to be used for any other purpose without the written consent of Harley Dykstra & Co.

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8. This drawing is not to be used for any other purpose without the written consent of Harley Dykstra & Co.

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Figure 1D: LSP Masterplan - Development Occurs within Lot 22 Clifton St (Client 2016)

2.0 Spatial consideration of bushfire threat

2.1 Bushfire Fuels and Potential Bushfire Impact

The location and extent of AS 3959 vegetation structures, including clause 2.2.3.2 low threat exclusions, within 100m of the site are mapped in Figure 2A and illustrated in the associated plates. Bushfire fuel loads are identified as consistent with AS 3959 Table B2 for radiant heat flux modelling purposes. All bushfire structures and fuel loads are assessed in their mature states (including revegetation and rehabilitation areas) unless otherwise identified.

Vegetation with current Lots 23 to 25 consists entirely of Low threat managed residential yards, extending immediately from the Canning River Foreshore. Lot 26 is overgrown with grasses and is classified as Class B Woodland. Lot 22 (aged care facility), is managed low threat for the north eastern portion of the lot, and consists of understorey managed Class A Forest for the balance of the lot to the Bush Forever boundary.

All vegetation on site will be removed as part of the development, with the exception of the Bush Forever area and vegetation the subject of the proposed Foreshore Management Plan. Public Open Space (POS) areas will be managed as low threat vegetation in accordance with AS3959 clause 2.2.3.2(f) through an approved Landscape Plan to be prepared and approved by the City of Armadale as a condition of subdivision approval.

As a precautionary measure, the BAL Contour modelling assumes that the Bush Forever area (Plot 1) is fully revegetated to Class A Forest vegetative state. Currently the area within the private lots is managed in a low fuel state. The final vegetation classification for the Bush Forever site is to be determined at the subdivision stage of planning in consultation with the Swan River Trust and other applicable stakeholders.

The vegetation structures are illustrated in the following photos, and Figures 2A – 2B identifies the location and direction of where each photograph was taken for both LSP proposals.

Plot 1



Pre Development

Class A Forest

Post Development

Class A Forest

Plot 1



Pre Development
Class A Forest

Post Development
Class A Forest. Includes precautionary approach for revegetation of Bush Forever site.

Plot 2



Pre Development
Class A Forest

Post Development
Class A Forest

Plot 3



Pre Development
Class B Woodland

Post Development
Class B Woodland

Vegetation to left of fence line and path

Plot 4



Pre Development

Exclusion 2.2.3.2 (f) maintained public reserves and parkland and urban development

Post Development

Exclusion 2.2.3.2 (f) maintained public reserves and parkland and urban development

Plot 5



Pre Development

Exclusion 2.2.3.2 (f) maintained public reserves

Post Development

Exclusion 2.2.3.2 (f) maintained public reserves

Plot 6



Pre Development

Exclusion 2.2.3.2 (f) maintained private land

Post Development

Exclusion 2.2.3.2 (f) maintained private land

Nearmap imagery (10/10/2016) used due to inability to access private property.

Plot 6 includes low threat areas within private yards.

Plot 7



Pre Development

Exclusion 2.2.3.2 (f) maintained public reserves and urban development

Post Development

Exclusion 2.2.3.2 (f) maintained public reserves and urban development

Plot 7



Pre Development

Exclusion 2.2.3.2 (f) maintained public reserves and urban development

Post Development

Exclusion 2.2.3.2 (f) maintained public reserves and urban development.

Plot 8



Pre Development

Exclusion 2.2.3.2 (f) maintained Public Open Space (maintained by City of Armadale)

Post Development

Exclusion 2.2.3.2 (f) maintained Public Open Space

(Maintained by City of Armadale – Refer to Appendix A, page 4, Recommendation 3)

Plot 9



Pre Development

Exclusion 2.2.3.2 (f) maintained urban development

Post Development

Exclusion 2.2.3.2 (f) maintained Public Open Space

Plot 9



Pre Development

Exclusion 2.2.3.2 (f) maintained urban development

Post Development

Exclusion 2.2.3.2 (f) maintained Public Open Space

Plot 10



Pre Development

Exclusion 2.2.3.2 (f) maintained Public Open Space (maintained by City of Armadale)

Post Development

Exclusion 2.2.3.2 (f) maintained Public Open Space

(Maintained by City of Armadale – Refer to Appendix A, page 4, Recommendation 3)

Plot 11



Pre Development
Class B Woodland

Post Development
Exclusion 2.2.3.2 (f) maintained Public Open Space

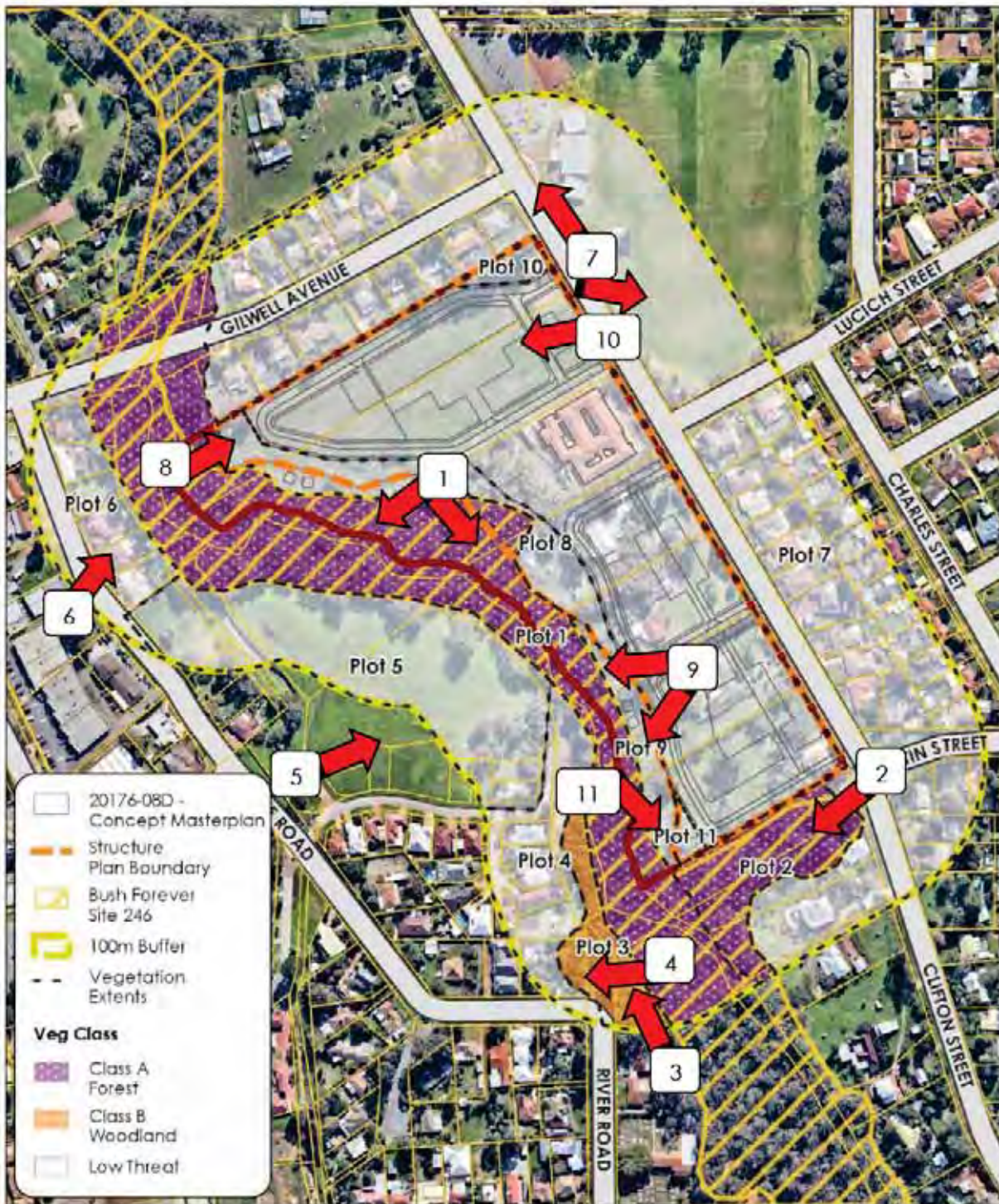
Plot 12



Pre Development
Class A Forest

Post Development (Scenario 1)
Exclusion 2.2.3.2 (e) and (f), cleared for future development

Post Development (Scenario 2)
Class A Forest



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

Vegetation Classification - no Plot 12

- Site Boundary
- Cadastre
- Main Road

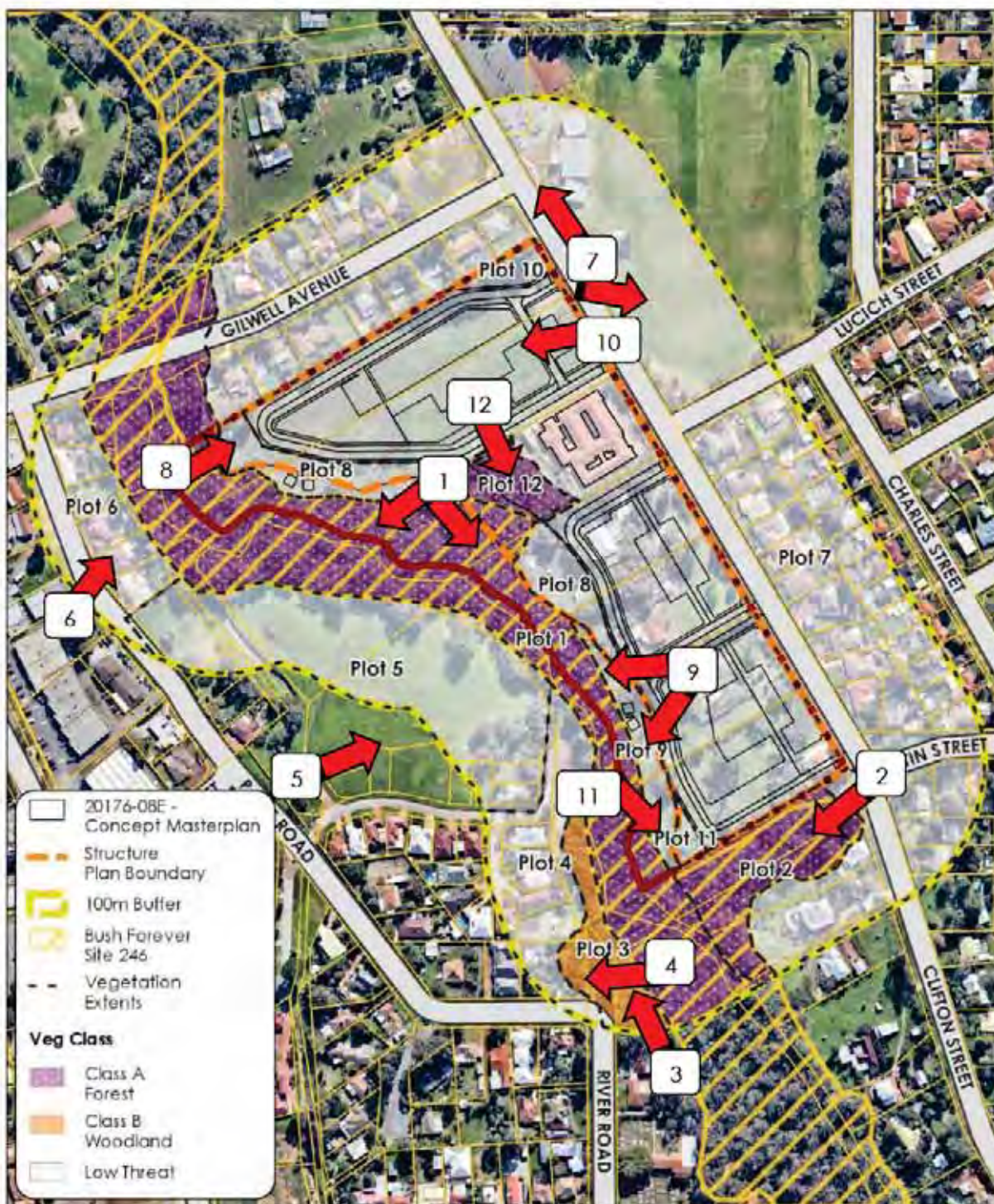
Size: A4
 Scale: 1:3,500



Proj: 5580_009_002_Veg_20170204
 Projection: GDA94 / MGA50
 Author: N/A - RUIC | Date: 2017/03/09
 Data Source: Cadastre - Landgate Imagery -
 Neoterminal; Site Boundary, Veg, 100m Buffer -
 BMU - RUIC.

Disclaimer: Although the data within this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2A: Vegetation Classification Map - Development Occurs within Lot 22 Clifton St



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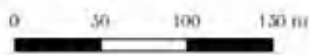
BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

Vegetation Classification- with Plot 12

- Site Boundary
- Cadastre
- Main Road



Size: A4
 Scale: 1:3,500



Proj: 5580_009_002_Veg_20170204
 Project#: 00494 AY0600
 Author: MM - RUIC | Date: 2017/03/09
 Data Source: Cadastre - Landgate Imagery -
 Westmap/Google, Site Boundary, Veg, 100m Buffer,
 BM - RUIC

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Figure 2B: Vegetation Classification Map - Development DOES NOT occur within Lot 22 Clifton St

The following table outlines the worst case BAL for each of the Plots post development, based on the vegetation class, effective slope and separation distance to the development (site) post development.

The effective slope along the Canning River Class A Forest vegetation is minimal. A 3-degree downslope has been incorporated into the modelling for the river reserve. Conservative effective slope has been used as part of the assessment based on that having the most significant effect on fire behaviour.

Table 2A: Maximum BAL rating that applies to the site (LSP area)

| Plot | Vegetation Classification | Effective Slope | Separation (m) | BAL Rating |
|------|--|-----------------|----------------|------------|
| 1 | Class A Forest | Downslope 3° | 4m | BAL-FZ |
| 2 | Class A Forest | Downslope 5° | 5m | BAL-FZ |
| 3 | Class B Woodland | Flat | 66m | BAL-12.5 |
| 4 | Exclusion 2.2.3.2 (e) &(f) maintained public reserves and urban development | N/A | N/A | N/A |
| 5 | Exclusion 2.2.3.2 (f) maintained public reserves (maintained by City of Armadale) | N/A | N/A | N/A |
| 6 | Exclusion 2.2.3.2 (e) Urban development | N/A | N/A | N/A |
| 7 | Exclusion 2.2.3.2 (e) &(f) maintained public reserves and parkland, and urban development | N/A | N/A | N/A |
| 8 | Exclusion 2.2.3.2 (f) maintained public reserves and parkland (future). Currently maintained public open space and private yards | N/A | N/A | N/A |
| 9 | Exclusion 2.2.3.2 (f) maintained public reserves and parkland. Currently maintained private yards | N/A | N/A | N/A |
| 10 | Exclusion 2.2.3.2 (f) maintained public reserves and parkland (future) | N/A | N/A | N/A |
| 11 | Exclusion 2.2.3.2 (f) maintained public reserves and parkland (future) | N/A | N/A | N/A |
| 12 | Class A Forest | Downslope 3° | 3m | BAL-FZ |

Potential bushfire impact analysis was undertaken in accordance with AS 3959 Methodology 1 for all plots except for Plots 1 and 12, which were modelled using AS3959-2009 Detailed Method (Method 2) to determine the potential worst case scenario radiant heat impact on the development area within the masterplan. In accordance with SPP 3.7, a BAL Contour Map has been prepared to illustrate the potential radiant heat impacts and associated BAL ratings for the assessment area after the development is completed (see Figures 2C to 2F).

2.1.1 Methodology 2 Modelling (Plots 1 and 12)

Standard inputs for the Detailed Method (Methodology 2), used to calculate the BAL separation distances are identified in Table 2B. Specific threat scenario inputs are listed in Table 2C.

Plots 1 and 12 effective slope is varied based on worst case slope of 3 degrees downslope, measured at 45 degrees to the Canning River alignment, for the direction of any fire run through the river reserve. As a precautionary measure flamewidth has been retained at 100m.

Table 2B: Standard inputs

| Design Bushfire Inputs | | Reference |
|------------------------|------------|--------------------------|
| FDI: | 80 | AS 3959-2009 Table 2.4.1 |
| Heat of combustion | 18600kj/kg | AS 3959-2009 Table 2.4.1 |
| Flame temperature | 1090K | AS 3959-2009 Table 2.4.1 |
| Ambient temperature | 308K | AS 3959-2009 Table 2.4.1 |
| Mean humidity | 25% | AS 3959-2009 Table 2.4.1 |

Table 2C: Site specific inputs

| Design Bushfire Input | Plots 1, 12 | Reference |
|-----------------------------|--|---------------------------------|
| Vegetation Classification: | Class A Forest | AS 3959-2009 Table 2.3 |
| Understory Fuel Load (t/ha) | 25 | AS 3959-2009 Table B2 |
| Total Fuel Load (t/ha) | 35 | AS 3959-2009 Table B2 |
| Effective Slope (°) | 3 | Site assessment & Landgate Data |
| Site Slope (°) | 0 | Site assessment & Landgate data |
| Flame Width (m) | 100 | Site assessment |
| Method 2 Justification | Effective slope based on slope along bank to creek line. | Site assessment |

BAL ratings as a function of separation distance from the predominant vegetation threats, as detailed in AS 3959-2009 Appendix B (Detailed Method, Methodology 2) are displayed in Table 2D.

Table 2D: Separation distances and BAL ratings – Plots 1 and 12

| Plots 1, 12 | |
|----------------------------------|---------------------------------|
| Vegetation Classification | Class A Forest |
| Effective Slope | Downslope 3° |
| BAL Method | Detailed Method (Methodology 2) |
| Separation Distance | BAL Rating |
| 0 to less than 19 m | BAL-FZ |
| 19 to less than 25 m | BAL-40 |
| 25 to less than 35 m | BAL-29 |
| 35 to less than 47.5 m | BAL-19 |
| 47.5 to less than 100 m | BAL-12.5 |
| 100 m and greater | BAL-LOW |

2.2 Bushfire Hazard Issues

From the BAL Contour Map, the following bushfire hazard issues have been identified.

- The proposed LSP site is exposed to radiant heat impacts greater than 29kW/m². However the indicative LSP design demonstrates future habitable buildings can be located within areas of BAL-29 or lower. Areas of the LSP with BAL ratings greater than BAL-29 will not be developed for habitable buildings and will instead be used for ancillary development purposes (i.e. landscaping, car parking areas etc).
- POS and natural areas are subject to an approved Landscape Management Plan at the subdivision stage of planning to ensure that vegetation establishment and ongoing maintenance meets the requirements of AS3959-2009 cl2.2.3.2 (f), low threat exclusion. This applies to identified Plots 8, 9, 10 and 11.
- Future residential Class 1, 2, 3 and associated Class 10a buildings are to be constructed to the applicable construction standard for the identified BAL rating per building.
- The BAL Contour map within this BMP is considered to be indicative only. A future BAL Contour Map is to be produced at the subdivision stage and final BAL ratings are to be confirmed post subdivision works, being prior to the building permit for any construction of any habitable buildings.

Bushfire Hazard Issues are addressed within Section 4 of this BMP.



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

BAL Contours - no Plot 12

- Site Boundary
- Cadastre
- Main Road
- 20176-08D-Concept Masterplan

Size: A4
 Scale: 1:3,500



Ref: 2069_1002_08_BALContours_20170209
 Projection: GDA94 (MGA50)
 Author: NWA - RUIC | Date: 2017-02-09
 Data Source: Cadastre - Landgate; Imagery -
 Westmap; Roads - Site Boundary, Veg, BAL, Buffer, BMS - RUIC.

Disclaimer: Although the author thinks this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2C: BAL Contour Map - Development Occurs within Lot 22 Clifton St



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

BAL Contours - Close In - no Plot 12



Size: A4
 Scale: 1:2,200



Ref: 9585_004L01_BALContoursCloseIn_20170204
 Projection: GDA94 MGA50
 Author: N/A - RUIC - J Date: 2017-02-09
 Data Source: Cadastre - Landgate Imagery
 Technical: Layout, Site Boundary, Veg, BAL, Buffer, BM - RUIC

Disclaimer: Although the data within this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability, whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2D: BAL Contour Map (Close-up) Development Occurs within Lot 22 Clifton St



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

BAL Contours - with Plot 12

- Site Boundary
- Cadastre
- Main Road



Size: A4
 Scale: 1:3,500



File: 2560_1002_02_BALContours_20170204
 Project: 00494 A04A00
 Author: MM - RUIC | Date: 2017-02-09
 Data Source: Cadastre: Landgate Imagery,
 Neoterm: Roads, Site Boundary, Veg, BAL, Buffer,
 BM - RUIC

Disclaimer: Although the author believes this map is considered accurate at the time of creation, RUIC does not guarantee, and accept no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2E: BAL Contour Map Development DOES NOT occur within Lot 22 Clifton St



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BUSHFIRE MANAGEMENT PLAN MAP
 Lot 20 to 26, Clifton Street, Kelmscott

BAL Contours - Close In - with Plot 12

- Site Boundary
- Cadastre
- Main Road



Size: A4
 Scale: 1:2,200



Ref: 9585_204_L01_BALContoursCloseIn_20170204
 Projection: GDA94 MGA50
 Author: MM - RUIC | Date: 2017-02-09
 Data Source: Cadastre - Landgate; Imagery -
 Aerial; Roads - Site Boundary, Veg, BAL, Buffer,
 BM - RUIC

Disclaimer: Although we believe that this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability, whatsoever, for any errors or omissions, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2F: BAL Contour Map (Close-up) Development DOES NOT occur within Lot 22 Clifton St

3.0 Proposal compliance and justification

3.1 State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP 3.7)

SPP3.7 applies to all development applications in designated bushfire prone areas.

3.1.1 Objectives

Policy Measure 5 contains the objectives of SPP3.7. The following demonstrates how the proposed development meets each of the objectives.

Objective 1: *Avoid any increase in the threat of bushfire to people, property and infrastructure. The preservation of life and the management of bushfire impact are paramount.*

Development Response

Objective 1 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 2: *Reduce vulnerability to bushfire through the identification and consideration of bushfire risks in decision-making at all stages of the planning and development process.*

Development Response

Objective 2 is satisfied through the appropriate identification and assessment of all relevant bushfire hazards as detailed in Section 2 of this report, specifically the BAL Contour Mapping.

Objective 3: *Ensure that higher order strategic planning documents, strategic planning proposals, subdivision and development applications take into account bushfire protection requirements and include specified bushfire protection measures.*

Development Response

Objective 3 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 4: *Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values, environmental protection and biodiversity management and landscape amenity, with consideration of the potential impacts of climate change.*

Development Response

Objective 4 is satisfied through the appropriate consideration of all biodiversity and environmental assets as detailed in Section 1 of this report in the development of bushfire related risk mitigation strategies detailed in Section 4 of this report.

3.1.2 Policy Measures

3.1.2.1 Strategic Planning Proposals

Policy Measure 6.2 requires that strategic planning proposals within designated bushfire prone areas and that have a BAL above BAL-LOW are to comply with Policy Measure 6.3.

3.1.2.2 Information to Accompany Strategic Planning Proposals

Policy Measure 6.3 applies to Strategic Planning Proposals. It requires certain information to be provided with such applications. The following outlines where the required information has been provided.

Table 3A: Compliance of the proposed development with the Policy Measures of SPP 3.7.

| Policy Measure | Description | Development Response |
|----------------|--|---|
| a | (i) the results of a BHL assessment determining the applicable hazard level(s) across the subject land, in accordance with the methodology set out in the Guidelines. BHL assessments should be prepared by an accredited Bushfire Planning Practitioner; or (ii) where the lot layout of the proposal is known, a BAL Contour Map to determine the indicative acceptable BAL ratings across the subject site, in accordance with the Guidelines. The BAL Contour Map should be prepared by an accredited Bushfire Planning Practitioner; and | Figures 2C-2F provide the BAL Contour Maps for both scenarios. |
| b | The identification of any bushfire hazard issues arising from the relevant assessment; and | Section 2.2 addresses the bushfire hazard issues. |
| c | Clear demonstration that compliance with the bushfire protection criteria in the Guidelines can be achieved in subsequent planning stages. | Section 4 provides an assessment of the development against the bushfire protection criteria. |

3.1.2.3 Vulnerable or High Risk Land Uses

The proposed development, is not known to introduce any vulnerable or high risk land uses. An existing aged care facility is located within Lot 22 Clifton St. The LSP provides for the potential redevelopment of this site in the long-term future for either standard residential development and/or as a new aged care facility. In any event, no new vulnerable land uses are proposed as part of the LSP.

3.1.2.4 Applications in BAL-40/BAL-FZ Areas

On completion of development, all habitable buildings are able to be located within areas of radiant heat not exceeding BAL-29.

3.1.2.5 Advice of State/Relevant Authority/s for Emergency Services to be Sought

The proposed LSP:

- Complies with the SPP3.7 Policy measures;
- Does not propose any additional/alternative measures;
- Does not contain unavoidable development, vulnerable or high risk land uses; and
- Is a **strategic planning proposal**.

Therefore, the advice of State/Relevant Authorities for Emergency Services is required to be sought for this application.

3.1.2.6 Advice of State/Relevant Agencies/Authorities for Environmental Protection to be Sought

The proposed development:

- Is not known to propose clearing of vegetation within environmentally sensitive areas protected under State or Federal legislation;
- Is not known to propose clearing of locally significant native vegetation; and
- **Does abut** vegetated land managed by that authority.

Therefore, the advice of State/Relevant Agencies/Authorities for Environmental Protection may be required to be sought for this application through the standard Local Structure Plan consultation and assessment process.

3.2 Guidelines for Planning in Bushfire Prone Areas (Guidelines)

The Guidelines apply to development applications located within designated bushfire prone areas. The Guidelines provide supporting information for implementation of SPP3.7. Specifically, they provide the Bushfire Protection Criteria to be address for all applications.

This report has also been developed in order to comply with the requirements of all referenced and applicable documents. No non-compliances have been identified.

4.0 Bushfire Risk Management Measures

The bush fire risk mitigation strategies detailed in this report are designed to comply with the Bushfire Protection Criteria detailed in Guidelines for Planning in Bushfire Prone Areas (GPBPA) Appendix 4 (2015).

- i. The notation (P3) refers to Performance Principle 3 of GPBPA Appendix 4.
- ii. The notation (A3.1) refers to Acceptable Solution 3.1 of GPBPA Appendix 4.
- iii. The notation (E3.1) refers to Explanatory Note 3.1 of GPBPA Appendix 4.
- iv. Where discrepancy occurs between State and Local bushfire planning provisions the higher standard of mitigation has been selected.

4.1 Element 1 - Location

Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

Performance Principle (P1): The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL-29 or below, and the risk can be managed. For minor or unavoidable development in areas where BAL-40 or BAL-FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.

Acceptable Solution A1.1 Development location

The strategic planning proposal, subdivision and development application is located in an area that on completion will be subject to a BAL-29 or below for all habitable buildings.

Development Response/Recommendations

As outlined in Figures 2B-2C, the development would ensure that all future habitable development areas are, upon completion of development, located in an area subject to BAL-29 or lower.

4.2 Element 2 - Siting and design of Development

Intent: To ensure that the siting of development minimises the level of bushfire impact.

Performance Principle (P2): The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. That it minimises the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.

Acceptable Solution A2.1 Asset Protection Zone (APZ)

Every building is surrounded by an Asset Protection Zone (APZ), depicted on submitted plans, which meets the following requirements:

- a. Width: 20 metres measured from any external wall of future buildings. Where the slope increases above 10 degrees, the APZ should be increased to ensure the potential radiant heat impact of a fire does not exceed 29kW/m²;
- b. Location: within the boundaries of the lot on which the building is situated;

- c. Fine fuel load: reduced to and maintained at 2 tonnes per hectare;
- d. Trees (crowns) are a minimum distance of ten metres apart. A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species;
- e. No tall shrubs or trees located within 2 metres of a building;
- f. No tree crowns overhanging the building;
- g. Fences and sheds within APZ are constructed using non-combustible materials (eg. iron, brick, limestone, metal post and wire); and
- h. Sheds within the APZ should not contain flammable materials.

Development Response/Recommendations

APZ's will be required to a distance to ensure that no habitable building is exposed to a BAL-40 or BAL-FZ. As illustrated in Figures 2C to 2F, APZs in conjunction with hazard separation areas indicate that A2.1 can be achieved.

Acceptable Solution A2.2 Hazard Separation Zone (HSZ)

Every building and its contiguous APZ is surrounded by a Hazard Separation Zone (HSZ), depicted on submitted plans, that meets the following requirements:

- a. Minimum width: 80 metres, measured from the outer edge of the APZ, for any vegetation classified in AS 3959 as forests, woodlands, closed shrub, open shrub, mallee/mulga and rainforest; OR 30 metres, measured from the outer edge of the APZ, for unmanaged grassland;
- b. Location: within the boundaries of the lot on which the building is situated or, where this is not possible or desirable, within the boundaries of the development precinct in which the building is proposed to be located; and
- c. Fine Fuel load (Dead Material <6mm diameter and <3mm for live material): reduced to and maintained at between five and eight tonnes per hectare for jarrah/marr dominated forest and woodlands, below 12-15 tonnes per hectare in mallee heath and below 15 tonnes per hectare in karri forest.

Note: A HSZ may not be required if the proposed construction meets the standard appropriate to the BAL for that location, and does not exceed BAL-29.

Development Response/Recommendations

Construction standards will be applied to relevant buildings in accordance with AS3959 as part of the future Building Permits. In this regard a HSZ is not required for this development.

A hazard separation area, consisting of roads and maintained parks and POS, provides additional separation distance from the identified classified vegetation.

4.3 Element 3 - Vehicular Access

Intent: To ensure that the vehicular access serving a subdivision/ development is safe in the event of a bush fire occurring.

Performance Principle (P3): The internal layout, design and construction of public and private vehicular access in the subdivision/development allows emergency and other vehicles to move through it easily and safely at all times.

| Solution | AS | PS | N/A | Comment |
|---|-------------------------------------|--------------------------|-------------------------------------|--------------------------------|
| A3.1 Two Access Routes | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| A3.2 Public Road | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| A3.3 Cul-de-sac | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A3.4 Battle-axe | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A3.5 Private Driveway longer than 50 metres | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A3.6 Emergency Access Way | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A3.7 Fire Service Access Routes | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A3.8 Firebreak width | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Applicable during construction |

Acceptable Solution A3.1 Two access routes

Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.

Development Response/Recommendations

The proposed LSP connects directly to Clifton St, providing access east and west and distanced from the bushfire threat. The proposed internal road layout enables two directions of travel.

Acceptable Solution A3.2 Public roads

A public road is to meet the requirements in Table 4A, Column 1.

Table 4A: Vehicular access technical requirements

| Technical Requirement | Public road | Cul-de-sac | Private driveway | Emergency access way | Fire service access routes |
|---------------------------------|-------------|------------|------------------|----------------------|----------------------------|
| Minimum trafficable surface (m) | 6 | 6 | 4 | 6 | 6 |
| Horizontal clearance (m) | 6 | 6 | 6 | 6 | 6 |
| Vertical clearance (m) | 4 | N/A | 4.5 | 4.5 | 4.5 |
| Maximum grade over <50m | 1 in 10 | 1 in 10 | 1 in 10 | 1 in 10 | 1 in 10 |
| Minimum weight capacity (t) | 15 | 15 | 15 | 15 | 15 |
| Maximum crossfall | 1 in 33 | 1 in 33 | 1 in 33 | 1 in 33 | 1 in 33 |
| Curves minimum inner radius (m) | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 |

Development Response/Recommendations

All public roads are to be designed to meet the requirements of Table 4A.

Acceptable Solution A3.3 Cul-de-sac (Including a dead-end road)

Development Response/Recommendations

N/A - No cul-de-sacs are to be incorporated into future subdivision design.

Acceptable Solution A3.4 Battle-axe

Development Response/Recommendations

N/A - No battle-axe lots are to be incorporated into future subdivision design.

Acceptable Solution 3.5 Private Driveway longer than 50 metres

Development Response/Recommendations

N/A - No private driveways are to be incorporated into future subdivision design.

Acceptable Solution 3.6 Emergency Access Way

Development Response/Recommendations

No Emergency Access Ways are proposed as part of the development. Therefore, A3.6 is not applicable to the development.

Acceptable Solution 3.7 Fire Service Access Routes (Perimeter Roads)

Development Response/Recommendations

No Fire Service Access Routes are proposed as part of the development. Therefore, A3.7 is not applicable to the development.

Acceptable Solution A3.8 Firebreak width

Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government.

Development Response/Recommendations

Any balance title lots are required to have a fire break installed in accordance with the requirements of A3.8 and the City of Armadale Firebreak Notice unless otherwise required to be an AP7 or low threat vegetation area. This will be addressed at the subdivision stage of planning

4.4 Element 4 – Water

Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

Performance Principle (P4): The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for firefighting purposes.

| Solution | AS | PBS | N/A | Comment |
|---|-------------------------------------|--------------------------|-------------------------------------|----------------|
| A4.1 Reticulated Areas | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| A4.2 Non-reticulated Areas | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |
| A4.3 Individual lots within non-reticulated areas | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | |

Acceptable Solution A4.1 Reticulated areas

The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.

Development Response/Recommendations

The site is located within a reticulated area, and will be serviced by reticulated scheme water and firefighting hydrants in accordance with the Water Corporation's Design Standard No.63, satisfying Acceptable Solution A4.1.

Acceptable Solution A4.2 Non-reticulated areas

Development Response/Recommendations

The development will be connected to reticulated water supply. Therefore, A4.2 is not applicable to this development.

Acceptable Solution A4.3 Individual lots within non-reticulated areas

Development Response/Recommendations

The development will be connected to reticulated water supply. Therefore, A4.3 is not applicable to this development.

5.0 Conclusion

The proposed development, on completion, will ensure that all habitable development is located in an area that has a low to moderate bushfire hazard level (i.e. BAL-29 or below). With the implementation of the Bushfire Management Strategies, as outlined in Section 4, the proposed development is considered to be appropriately protected from bushfire and complies with the requirements of SPP3.7 and the Guidelines. The proposed development is not expected to increase the bushfire risk.

6.0 References

- Ecosystem Solutions. (2015). Bushfire Management Plan, Lots 20-26 Clifton St, Kelmscott. Dunsborough
- Ecosystem Solutions. (2016). Bushfire Management Plan, Lots 20-26 Clifton St, Kelmscott. Dunsborough
- DFES (2016). Land Use Planning Referral – City of Armadale. Department of Fire and Emergency Services. Perth
- Standards Australia. (2009). AS 3959:2009 Construction of buildings in bushfire prone areas: SAI Global.
- WAPC. (2006). State Planning Policy 3.4 Natural Hazards and Disasters. State Law Publisher.
- WAPC. (2015a). State Planning Policy 3.7 Planning in Bushfire Prone Areas. Western Australian Planning Commission & Department of Planning.
- WAPC. (2015b). Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission, Department of Planning & Department of Fire and Emergency Services.
- WAPC. (2015c). Guidelines for Planning in Bushfire Prone Areas Appendices. Western Australian Planning Commission, Department of Planning & Department of Fire and Emergency Services.
- WAPC. (2015d). Planning Bulletin 111/2015 Planning in Bushfire Prone Areas. Western Australian Planning Commission.
- WAPC. (2015e). Planning Bulletin 111/2016 Planning in Bushfire Prone Areas. Western Australian Planning Commission.

7.0 Appendix A – Council Minutes (3 December 2016)

Officer's Recommendation -

That Council:

- I. Pursuant to Schedule 2, Clause 20 of the *Planning and Development (Local Planning Schemes) Regulations 2015*, support the Canning River Precinct - Clifton Street South Structure Plan subject to the following modifications:
 - a) The coding of the front strip of Lots 20, 21 and 22 opposite Frye Park be lowered to R40 and the maximum building height of two stories also be extended along the whole of the Clifton Street frontage;
 - b) Extend the road reserve of the first new road reserve (unconstructed) to the rear boundary of Lot 21 (No.53) Gilwell Avenue to provide for future redevelopment with alternate road access;
 - c) Modify the alignment of the first loop road between the R80 area on Lots 20 and 21 and the POS to provide safer vehicle movement. This will result in a slight increase in the width of the POS in that location;
 - d) Update the Floodway and Flood Fringe mapping on the Structure Plan and supporting documentation with the recent updated modelling data and mapping prepared by the Department of Water and the Water Corporation;
 - e) Update the correct plan reference number in Part 1, 6.3 ("Plan 2" is not in the document) and use the standard terms of "Floodway" and "Flood Fringe" (in place of the non-standard term "Floodway Fringe" used in draft documents);
 - f) Modify the Structure Plan to include a clear depiction of the total area of Lots 20 to 26 and hence the total public parkland area to be ceded upon subdivision/development of the "Urban" zoned portions of the lots including local POS and the balance "Rural" zone portions which define the foreshore reserve requirement;
 - g) Modify the Structure Plan to show all lots providing as a minimum local POS Contribution as land, 5% of the Developable Area with the balance 5% portion based on the 10% policy standard, provided as Cash in Lieu. The additional POS land for those lots with currently less than 5% (being Lot 25) to be achieved by redesign, locating POS immediately adjacent to the riverside road;
 - h) Amend text on the Structure Plan and Provision 6.2 to restrict Building Heights as follows:
 - R60 and R80 – minimum building height 2 stories and maximum building height 3 stories;
 - R40 - maximum building height 2 stories;
 - i) Add the following new Provision to the Structure Plan:

Each land owner will be required to make a subdivision/development contribution towards the road upgrading of Gilwell Avenue to cater for traffic volumes anticipated by the Structure Plan. Value of works to be determined following detailed design of the upgrade works by the City.

- j) Include the following new Provision on the Structure Plan:
Development plans and applications are to have regard to designing out crime principles.
 - k) Finalisation of the Bushfire Management Plan.
2. Forward the Structure Plan, report submission and recommendation of support to the Western Australian Planning Commission for consideration for approval in accordance with the Planning and Development (Local Planning Schemes) Regulations 2015.
 3. Note that the Western Australian Planning Commission will require the finalisation of the Bushfire Management Plan (to the satisfaction of DFES and the City), prior to its consideration of the Structure Plan
 4. Advise the Western Australian Planning Commission that the City will accept Management Orders (Vesting) for land ceded as a *Foreshore Reserve* on the Canning River as a result of subdivision and/or development in accordance with the Structure Plan for the Canning River Clifton Street South Precinct.
 5. Include for consideration the funding in the next review of the Long Term Financial Plan, in year 3 (i.e. 2018/19), the preparation of a Foreshore Management Plan as explained in parts (a) and (b) hereunder:
 - a) The Foreshore Management Plan is to set out the objectives and management actions/landscape works to be implemented in the future Foreshore Reserve for the protection of the environmental and heritage/cultural values of the Canning River and foreshore; and
 - b) Upon the ceding of the land and declaring Management Orders for foreshore reserves in stages of contiguous land parcels, list the Foreshore Management Plan project works for consideration for inclusion in the next Annual Budget/s

Committee discussed the importance of the foreshore management plan to the community, who should fund and timing of the foreshore management plan, width of foreshore reserve, previous MRS amendment and determination of the width of foreshore reserve, possibility of a future pedestrian bridge, WAPC's 10% public open space requirement, bushfire management plan, the Department of Water's approval of Local Water Management Strategy received on 7 December 2016, heritage Rosebushes, lots fronting Gilwell Avenue, development application, local development plans, WAPC's role as the determining authority for the Structure Plan, technical information and reports provided by the applicant and its consultants, traffic issues, the densities and height restrictions proposed in the structure plan and need for pedestrian linkages. Committee resolved to modify the recommendation to recommend to the WAPC that the proposed Structure Plan should not be approved until a number of matters are satisfactorily addressed.

RECOMMEND

D52/12/16

1. Recommend to the Western Australian Planning Commission that the proposed Structure Plan should not be approved until such time as the following matters have been satisfactorily addressed:
 - (a) A Bushfire Management Plan be prepared to demonstrate that no proposed residential development will be subject to a BAL rating of 40 or FZ.
 - (b) Preparation of an Environmental Assessment Report, consistent with the

requirements of the Structure Plan Framework.

- (c) The Traffic Report does not provide information consistent with the Transport Impact Assessment Guidelines: Volume 2 – Planning Schemes, Structure Plans and Activity Centre Plans (2016). The Traffic Report is required to be expanded upon to address the matters required within the Guidelines.
- (d) A Foreshore Management Plan being prepared which sets out the objectives and management actions/landscape works to be implemented in the future Foreshore Reserve for the protection of the environmental and heritage/cultural values of the Canning River and foreshore.
- (e) Update the Floodway and Flood Fringe mapping on the Structure Plan and supporting documentation with the recent updated modelling data and mapping prepared by the Department of Water and the Water Corporation.
- (f) Update the correct plan reference number in Part 1, 6.3 (“Plan 2” is not in the document) and use the standard terms of “Floodway” and “Flood Fringe” (in place of the non-standard term “Floodway Fringe” used in draft documents).
- (g) Amend the Structure Plan to replace the R80 coding with R60 coding.
- (h) Amend text on the Structure Plan and Provision 6.2 to restrict Building Heights as follows:
 - R60 - minimum building height 2 stories and maximum building height 3 stories;
 - R40 - maximum building height 2 stories.
- (i) The coding of the front strip of Lots 20, 21 and 22 opposite Frye Park be lowered to R40 and the maximum building height of two stories also be extended along the whole of the Clifton Street frontage.
- (i) Extend the road reserve of the first new road reserve (unconstructed) to the rear boundary of Lot 21 (No.53) Gilwell Avenue to provide for future redevelopment with alternate road access.
- (k) Modify the alignment of the first loop road between the R60 area on Lots 20 and 21 and the POS to provide safer vehicle movement. This will result in a slight increase in the width of the POS in that location;
- (l) Modify the Structure Plan to include a clear depiction of the total area of Lots 20 to 26 and hence the total public parkland area to be ceded upon subdivision/development of the “Urban” zoned portions of the lots including local POS and the balance “Rural” zone portions which define the foreshore reserve requirement;
- m) Add the following new Provision to the Structure Plan:

Each land owner will be required to make a subdivision/development

contribution towards the road upgrading of Gilwell Avenue to cater for traffic volumes anticipated by the Structure Plan. Value of works to be determined following detailed design of the upgrade works by the City.

- n) Modify 6.7 of the structure plan to include pedestrian linkages / paths.
- 2. In the event that the proposed Structure Plan is modified in order to address the matters raised by the Council, the City be consulted prior to the proposal being determined by the Western Australian Planning Commission.
- 3. Advise the Western Australian Planning Commission that the City will accept Management Orders (Vesting) for land ceded as a *Foreshore Reserve* on the Canning River as a result of subdivision and/or development in accordance with the Structure Plan for the Canning River Clifton Street South Precinct.

Moved Cr D M Shaw
MOTION CARRIED

(6/0)

Cr Norman returned to the meeting at 8.36pm.

Cr Busby left the meeting at 8.36pm and did not return.

APPENDIX C

Local Water Management Strategy & DoW Approval Bayley Environmental Services

The Local Water Management Strategy was approved by the DoW in advance of the approval of the Local Structure Plan by the WAPC. Minor modifications to the LSP layout were required by the WAPC which are inconsequential to the water management strategies and requirements outlined in the approved LWMS. Further water management reporting will be required at the subsequent stages in the planning and development process and the minor modifications to the LSP layout are to be incorporated as part of this subsequent reporting.



Your ref: J13022
File ref: RF14429 PA011093
Enquiries: Tara Fox
Tel: 6250 8008

Bayley Environmental Services
30 Thomas St
SOUTH FREMANTLE WA 6162

Attention: Phil Bayley - bayley@iinet.net.au

Dear Sir/Madam,

CLIFTON ST SOUTH PRECINCT, KELMSCOTT – LOCAL WATER MANAGEMENT STRATEGY

The Department of Water (DoW) has finalised its assessment of the above mentioned Local Water Management Strategy dated November 2016, prepared by Bayley Environmental Services for Harley Dykstra. The DoW is satisfied that the document is acceptable for this proposal to proceed to the next stage of the development approval.

If you wish to discuss the matter further, please contact Tara Fox on 6250 8008 or via email – tara.fox@water.wa.gov.au.

Yours sincerely,

Carlie Slodecki
A/Program Manager
Land Use Planning
Swan Avon Region

7 December 2016

cc: Matthew Tapscott – City of Armadale - mtapscott@armadale.wa.gov.au

Save time with Water Online

You can now lodge referrals electronically via the Water Online customer portal at www.water.wa.gov.au. Water Online provides the fastest and most efficient process for submitting referrals or requests for planning advice.

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For submission of management plans (DWMS, LWMS etc.), in Planning Advice create a 'New Request' and in 'Request Details' please select the 'Request category' – 'Reports and policies' and 'Request type' – 'Reports for Better Urban Water Management'.

**CLIFTON STREET SOUTH PRECINCT
LOTS 20 – 26 CLIFTON ST, KELMSCOTT
LOCAL WATER MANAGEMENT STRATEGY**

Prepared for

Harley Dykstra
PO Box 316
KELMSCOTT WA 6991

Report No. J13022
7 November 2016

BAYLEY ENVIRONMENTAL SERVICES
30 Thomas Street
SOUTH FREMANTLE WA 6162

EXECUTIVE SUMMARY

Background

The Clifton Street South Precinct Local Structure Plan sets out a framework for subdivision and redevelopment of Lots 20-26 Clifton St, Kelmscott. The LSP proposes to subdivide the subject land, totalling about 8ha, into a range of R40, R60 and R80 residential lots. The LSP also proposes approximately 0.89ha of Public Open Space, comprising about 14.2% of the total developable area. A further 1.75ha, comprising the river foreshore and most of the floodway, will be ceded as Regional Open Space.

The subject land is located immediately east of the Canning River, and the river is a major factor influencing the design of the LSP. Other influences on the LSP are:

- existing land uses on the site (private houses, vacant land and one aged care facility on 1.0 - 1.6ha lots);
- mostly flat topography with largely impermeable silty clay soils, and a steep fall down to the river channel;
- the 100-year floodplain of the Canning River;
- an existing underground municipal drain running through the site;
- remnant native vegetation (mostly mature Flooded Gums) along the river foreshore; and
- areas of saturation and seepage along the slope near the river.

The Canning River will be protected by a foreshore reserve that has been determined by a lengthy investigation and consultation process involving the WAPC, EPA, DoW, DPAW and City of Armadale. The foreshore reserve will be formalised in a combination of Regional and Public Open Space.

Water Use Efficiency

The redevelopment of the LSP area will be very efficient in its use of water in public areas, with long-term irrigation limited to a 700m² area of POS. The foreshore reserve will be rehabilitated with native species that do not require ongoing irrigation. Some irrigation may be applied during the first two years, but the clay soils may make this unnecessary.

Private ex-house water use is expected to be small as a result of the high development density and consequent absence of large lawns and gardens. In-house water use will

be minimised by the application of 5-star Plus Building Standards in accordance with the *Building Code of Australia 2012*.

Drainage Management

The proposed development will cause an increase in the overall imperviousness of the subject land. Given the clay soils of the site and consequent high runoff rates, this increase will be smaller than for a similar development on a sandy catchment. However, the clay soils also reduce the opportunities for at-source infiltration of runoff.

The drainage system for the LSP area is designed to maintain as nearly as possible the existing hydrology of the subject land and the river. The essential features of the drainage system are:

- Runoff from building roofs will be captured and infiltrated in soakwells where possible (depending on soil permeability), in accordance with Building Code of Australia (BCA) requirements. Otherwise, in-lot detention with piped outflow may be employed to reduce flow rates from small storms.
- Runoff from paved ground within private lots (e.g. driveways) will be partly captured by lawns and gardens, with the excess flowing into the road drainage system.
- Road runoff from the first 15mm of rainfall in each storm (roughly equivalent to a 1 year ARI, 1 hour duration storm) will be captured by the road drainage network and wholly infiltrated in bioretention basins (rain gardens), which will be engineered and vegetated to achieve high removal of contaminants while avoiding prolonged ponding of stormwater. The preliminary road drainage system has been designed as a traditional piped system. Alternative layouts such as the use of roadside swales in place of pipes will be further examined in the detailed design of each stage of subdivision.
- Runoff from larger storms up to 100-year ARI will be conveyed by a combination of pipe/swale and pavement flow to detention basins, from where they will be infiltrated or progressively released to the Canning River. The size of the basins and the overflows will be designed to maintain the peak flows from the site at pre-development levels.

Groundwater Management

The proposed development is expected to have no effect on groundwater levels or quality over most of the site, as a result of the impermeable clay soils and depth to groundwater. A small area in the south-west on Lots 25 and 26 with sandy surface soils and a perched winter water table may require subsoil drainage to limit groundwater rise. If subsoil drains are installed they will discharge into the bioretention basins.

Dewatering is unlikely to be required for the installation of underground services.

Groundwater quality will be protected by a combination of the adsorptive clay soils, treatment of runoff and minimal use of fertilisers in landscaping and POS areas.

Implementation and Further Management Plans

Urban Water Management Plans will be prepared for each stage of subdivision within the LSP area. The UWMPs will set out detailed drainage designs, landscape plans and monitoring programs for each stage of subdivision.

A Foreshore Management Plan will be prepared prior to the first stage of subdivision to guide rehabilitation and management in the foreshore area.

The City of Armadale will assume the vesting and manage the foreshore reserves and local POS upon subdivision that cedes the foreshore reserves to the Crown. The City will continue to plan the management of the foreshore areas in the Canning River Precinct in consultation with the relevant government agency and community stakeholders.

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1.0 INTRODUCTION

1.1 Background

Harley Dykstra has prepared a Local Structure Plan for Lots 20-26 Clifton St, Kelmscott, on behalf of the City of Armadale (the owner of Lots 20 and 21) and the owners of Lots 24 and 25. The LSP proposes to subdivide the subject land, totalling about 8ha, into a range of R40, R60 and R80 residential lots. The LSP also proposes approximately 0.89ha of Public Open Space, comprising about 14.2% of the total developable area. A further 1.75ha (approximately), comprising the river foreshore and most of the floodway, will be ceded as Regional Open Space. Figure 1 shows the draft Local Structure Plan.

The subject land is zoned Urban in the Metropolitan Region Scheme (MRS). The land to the north and east is also zoned Urban. The land immediately to the south and west is zoned Rural and separates the subject land from the Canning River Waterways reservation. A Bush Forever overlay also covers part of the subject land, generally following the alignment of the Canning River.

The subject land was rezoned from Rural to Urban under the MRS in May 2012 (amendment 1202/41).

As a brownfield site, no formal District Water Management Strategy (DWMS) has been prepared for the subject land, although an outline DWMS was provided as part of the *Canning River Precinct Environmental Study* (Enviroworks, 2009) prepared for the Department of Planning and the City of Armadale.

1.2 Planning Context

The City of Armadale and the WAPC, in consultation with the Swan River Trust (SRT), Department of Water (DoW) and Environmental Protection Authority (EPA), have been engaged in a long-term program of consultation and planning for land use and zoning changes and the reservation of the Canning River foreshore. Planning and consultation for the Precinct has progressed through various stages over the past 17 years between 1999 and 2016:

1999 to 2004 Preliminary Strategic Municipal and District Planning

- The *Residential Neighbourhood Strategy - Discussion Paper* first flagged the proposed change in land use (Rural to Urban). It was prepared as one of the consultation discussion papers which preceded the Review of TPS No.2 and No.3) and advertising of a draft TPS 4. The Discussion Paper was advertised for public submissions in 1999.

- The *Kelmscott Enquiry-By-Design Workshop* (2002 - 3) was undertaken jointly by the City of Armadale and the Department of Planning with community representative participation through Focus Groups and in the Workshop Forum. It prepared initial land use and foreshore landscaping concepts for land use change to urban use combined with a proposed new foreshore reserve frontage to the Canning River. The Workshop Report was advertised for public submissions in 2003.
- The City of Armadale *Local Planning Strategy* earmarked the Canning River Precinct for future urbanisation under TPS No.4. The LPS was advertised for public submissions with draft TPS No.4 in 2004 (gazetted 5 November 2005).

2005 Planning at the Precinct level

- The *Canning River Precinct Study* series of consultant-facilitated stakeholder workshops was conducted jointly by the City of Armadale and the Department of Planning in 2005. Community representatives, precinct landowners and State environmental and land management agencies participated in the workshops:
 - Stakeholders Workshop (W/S No. 1) - 26th May 2005;
 - Stakeholders Workshop (W/S No. 2) – 20th July 2005;
 - Public Workshop (W/S No. 3) – 17th August 2005

Invitations to the outcomes workshop were extended to stakeholder landowners, nearby residents and the general public by Notices in the local paper and on the City's website. Frequently Asked Questions and information were provided on the City's website.

Statutory Planning Amendments to MRS and TPS No.4 (2009 to 2014)

- The *Environmental Review – Canning River Precinct* (2009) was undertaken by the City of Armadale and the WAPC at the request of the EPA and State environmental agencies. The findings of the study informed the Urban zoning in the WAPC's Metropolitan Region Scheme (MRS) Amendment 1202/41. The study included the definition of a Canning River foreshore reserve based on the methodology set out in EPA Guidance 33 (Section 5: Waterways) and policy guidelines for determining foreshore reserves, including WRC *River Restoration 16: Determining Foreshore Reserves*.

The resulting MRS Amendment was advertised for public submissions from 25th January to 29th April 2011. Public Hearings were conducted by the Planning Commission (WAPC) in August 2011. The MRS Amendment, which was gazetted in May 2012, delineated the extent of the Urban zone, which formed the Structure Plan area, while retaining the identified foreshore reserve in the Rural zone.

- *TPS No. 4 Amendment No. 70* was prepared following gazettal of MRS 1202/41 in order to make the TPS consistent with the MRS. The TPS Amendment was advertised for public submissions in May 2013 and Gazetted in February 2014.

Draft Local Structure Plan (2015)

- The draft Local Structure Plan prepared by Harley Dykstra (on behalf of landowners) for the Canning River Clifton Street (South) precinct was advertised for public submissions in November 2015. Submissions on the Local Structure Plan closed in January 2016.

1.3 Scope of the LWMS

This LWMS has been prepared in support of the Local Structure Plan to:

- Document the existing environment on the site in relation to soils, drainage, erosion, watercourses, groundwater and water dependent ecosystems.
- Briefly describe the proposed development in relation to water management.
- Address relevant regulatory requirements and design criteria for water harvesting, groundwater management and drainage.
- Describe the strategies to be implemented for water conservation, groundwater management and stormwater drainage.
- Outline the proposed monitoring program.
- Outline what is to be addressed in future water management plans for developments within the LSP area.

1.4 Relevant Guidelines and Policies

1.4.1 State Planning Policy 2.9

State Planning Policy 2.9: *Water Resources* (WAPC, 2006) lists the following key principles for total water cycle management:

- Consideration of all water sources (including wastewater) in water planning, maximising the value of water resources.
- Integration of water and land use planning.

-
- Sustainable and equitable use of all water sources, having consideration of the needs of all water users including the community, industry and the environment.
 - Integration of water use and natural water processes.
 - A whole-of-catchment integration of natural resource use and management.

SPP 2.9 also lists the following general objectives for water-sensitive urban design:

- To manage a water regime.
- To maintain and, where possible, enhance water quality.
- To encourage water conservation.
- To enhance water-related environmental values.
- To enhance water-related recreational and cultural values.

Element 5 of *Liveable Neighbourhoods* Edition 3 (WAPC, 2004) identifies specific objectives and requirements for Urban Water Management. These are based on Best Planning Practices which are defined as the best practical approach for achieving water resource management objectives within an urban framework.

1.4.2 Better Urban Water Management

Better Urban Water Management (WAPC, 2008) sets out the following objectives for water sensitive urban design:

Water Conservation

- Consumption of 100kL/p/yr including less than 40-60 kL/p/yr scheme water.

Water Quantity

- Ecological Protection – Maintain pre-development flow rates and volumes for the 1 year ARI event. Maintain or restore desirable environmental flows and/or hydrological cycles.
- Flood Management – Maintain pre-development flow rates and volumes for the 100 year ARI event.

Water Quality

- Maintain pre-development nutrient outputs (if known) or meet relevant water quality guidelines (e.g. ANZECC & ARMCANZ, 2000).
- Treat all runoff in the drainage network prior to discharge consistent with the Stormwater Management Manual.

- As compared to a development that does not actively manage stormwater quality, achieve:
 - at least 80% reduction of Total Suspended Solids;
 - at least 60% reduction of Total Phosphorus;
 - at least 45% reduction of Total Nitrogen; and
 - at least 70% reduction of gross pollutants.

Mosquitoes and Midges

- Design detention structures so that, between the months of November and May, stormwater is fully infiltrated within 96 hours.
- Design permanent water bodies (where accepted by DoW) to maximise predation of mosquito larvae by native fauna.

1.4.3 DoW Guideline: Developing a Local Water Management Strategy

Developing a Local Water Management Strategy (DoW, 2008) sets out the Department of Water's recommended content and layout for an LWMS in line with *Better Urban Water Management* (WAPC, 2008).

This LWMS has been prepared in line with the DoW guidelines.

1.4.4 Local Planning Policy PLN2.6: Water Sensitive Urban Design

The City of Armadale's Local Planning Policy PLN2.6 seeks to integrate development with enhance the qualities of the natural environment by:

- preventing contamination of stormwater through education and design;
- using appropriate technology;
- using the natural ability of watercourses and water bodies to improve water quality; and
- revegetating existing stormwater drains with local species to enhance their values and visual appeal.

The Policy sets out the following principles for design and assessment of best management practice in water-sensitive design:

- (a) Water resource management is addressed at the sub-catchment level.
- (b) Multiple use corridors located within Public Open Space are used when appropriate.
- (c) Storage, stormwater use and stormwater treatment occur as high as possible in the catchment, a treatment train approach is used and components of stormwater management are located so they follow natural contours.

- (d) Stormwater system design incorporates as much as possible features of waterways that improve water quality.
- (e) Fringing vegetation along watercourses and around protected wetlands and associated significant upland vegetation is considered for retention and rehabilitation where practical.
- (f) Property is protected from flooding or damage by surface water or groundwater.
- (g) Post-urban development conditions in watercourses approximate pre urban conditions (i.e. water level and flow regimes are maintained) (unless it can be demonstrated that the downstream channel and floodplain has the capacity to accept higher flows to the satisfaction of the Department of Water).
- (h) The area of open drain habitat is maintained or increased over time.

The Clifton Street LSP and this LWMS have been prepared in line with the principles of PLN2.6.

1.5 Previous Studies

Canning River Precinct Environmental Review (2009)

The Canning River Precinct Environmental Review (Enviroworks, 2009) was undertaken by the Department of Planning and the City of Armadale over a 2km stretch of Canning River foreshore and adjacent upland that had been identified for possible infill urban redevelopment, including the Clifton St South Precinct. The objective of the study was to investigate the environmental features of the foreshore, identify areas suitable for Parks and Recreation reservation and define a foreshore reserve for incorporation into the Metropolitan Region Scheme.

The study included review of existing biophysical information (including Bush Forever, floodway mapping, Swan River Trust Development Control Area), on-site investigations and consultation with agencies including the Department of Environment & Conservation and the Department of Water, and site investigations. A biophysical assessment was undertaken in accordance with EPA Guidance 33 (Section 5: Waterways) and WRC RR16: *Determining Foreshore Reserves*.

The foreshore reserve identified by the study has been incorporated into the MRS as an interim Rural zoning before a Parks & Recreation Reservation is implemented in accordance with WAPC practices (WAPC, 2012). The foreshore reserve is covered by a Development Control Area under the *Swan and Canning Rivers Management Act 2005*. It forms the western boundary of the structure plan area for the Clifton St South Precinct.

2.0 PRE-DEVELOPMENT ENVIRONMENT

2.1 Rainfall

Kelmscott, like the rest of the Perth region, has a strongly seasonal rainfall, with most of the annual rain falling between May and September in association with winter cold fronts. Occasional heavy falls may occur from summer thunderstorms. The long-term average annual rainfall for Perth Airport is 774.7mm, of which over 78% falls between the months of May and September.

Figure 2 shows a rainfall occurrence chart for Perth Airport. Figure 3 and Table 2.1 show rainfall intensity and frequency for Kelmscott.



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Bureau of Meteorology

Figure 2 Perth Airport Mean Rainfall



Figure 3 Rainfall Intensity Chart for Kelmscott

Intensity-Frequency-Duration Table

Location: 32.125S 116.025E NEAR.. Kelmscott Issued: 3/11/2014

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

| Average Recurrence Interval | | | | | | | |
|-----------------------------|--------|---------|---------|----------|----------|----------|-----------|
| Duration | 1 YEAR | 2 YEARS | 5 YEARS | 10 YEARS | 20 YEARS | 50 YEARS | 100 YEARS |
| 5Mins | 64.5 | 84.3 | 108 | 125 | 149 | 184 | 213 |
| 6Mins | 60.2 | 78.7 | 101 | 117 | 139 | 171 | 199 |
| 10Mins | 48.1 | 62.7 | 79.7 | 91.5 | 108 | 132 | 153 |
| 20Mins | 33.6 | 43.4 | 54.1 | 61.4 | 71.8 | 86.9 | 99.5 |
| 30Mins | 26.7 | 34.3 | 42.3 | 47.8 | 55.6 | 66.8 | 76.1 |
| 1Hr | 17.6 | 22.5 | 27.4 | 30.7 | 35.4 | 42.2 | 47.8 |
| 2Hrs | 11.5 | 14.7 | 17.7 | 19.6 | 22.6 | 26.7 | 30.1 |
| 3Hrs | 8.96 | 11.4 | 13.7 | 15.2 | 17.4 | 20.5 | 23.1 |
| 6Hrs | 5.86 | 7.43 | 8.88 | 9.81 | 11.2 | 13.2 | 14.8 |
| 12Hrs | 3.83 | 4.86 | 5.80 | 6.41 | 7.32 | 8.62 | 9.66 |
| 24Hrs | 2.48 | 3.15 | 3.78 | 4.20 | 4.81 | 5.67 | 6.38 |
| 48Hrs | 1.56 | 2.00 | 2.42 | 2.70 | 3.12 | 3.70 | 4.19 |
| 72Hrs | 1.16 | 1.49 | 1.82 | 2.04 | 2.36 | 2.82 | 3.21 |

(Raw data: 23.06, 5, 1.54, 37.34, 7.76, 2.54, skew=0.68, F2=4.85, F50=17.1)

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Table 2.1 Rainfall Intensity for Kelmscott

2.2 Physiography

2.2.1 Topography

The project area is situated on an alluvial plain immediately east of the Canning River. In the southern part, the land falls to the west at a grade of between 4.5% and 7.5%, while in the north the land is almost flat, with a slope to the west of only 0.5%. The slope increases markedly on the western edge of the project area, where the land falls into the Canning River floodway.

2.2.2 Geology, Landforms and Soils

The development area is located mostly on colluvium (Qc), formed by erosion of material from the Darling Scarp. The Geological Survey of Western Australia (Jordan, 1986) mapped the soils of most of the project area as gravelly sandy clay (Csg). The valley of the Canning River, including parts of the western and southern edges of the project area, were mapped as alluvial sandy silt (Qha/Ms₄). Figure 4 shows the GSWA mapping.

Drilling of four boreholes across the site (Figure 4) revealed generally silty clay soil profiles that largely generally matched the GSWA mapping. An exception was Bore KB3, in the south-east of the project area (Lot 25), that found a grey silty sand profile to the full depth of 4.5m. The extent of this sand lens is unclear but may include the southern part of Lot 25 and part of Lot 26. Borehole logs from the drilling are attached in Appendix A.

Detailed geotechnical assessments will be required as part of subdivision design to ascertain the site classification for building purposes.

2.2.3 Soil Permeability

Constant-head permeability tests were carried out at 0.5m depth at nine sites (Figure 4) in October 2014, targeting the likely locations of infiltration basins. The tests were conducted in accordance with Australian Standard AS1547:2000. The results of the permeability tests are detailed in Appendix B and summarised in Table 2.2.

Table 2.2 Soil Permeability Test Results

| <i>Test Location (see Figure 4)</i> | <i>Saturated Hydraulic Conductivity Ks (m/day)</i> |
|---|--|
| KI1 | 6.5 |
| KI2b | 0.5 |
| KI2c | 3 |
| KI3 | 0 (no infiltration after 1 hr) |
| KI5 | 0 (no infiltration after 1 hr) |
| KI6 | 5.5 |
| KI7 | 0.5 |

Table 2.2 shows that the surface soils have low to very low permeability, as is typical of silty clay soils. The higher permeabilities in K11 and K16 occurred in limited areas of loamy soils. Overall, it would appear that infiltration into the natural soils will be minimal. This suggests that infiltration basins will need to be engineered with imported permeable soils underlain by subsoil drains. For design purposes, the permeability of the natural soils is assumed to be zero.

2.2.4 Acid Sulphate Soils

The Department of Parks & Wildlife (DPAW) maps the floodway of the Canning River (including the western edge of the project area) as having a High risk of actual or potential acid sulphate soils (ASS). The majority of the project area is mapped as low to Nil ASS risk. Figure 4 shows the DPAW ASS mapping.

Analysis of groundwater samples from the four bores shown on Figure 4 showed no significant evidence of ASS, with low acidity, high alkalinity, low sulphate, neutral pH and low metal concentrations. Nevertheless, should significant excavation or dewatering occur in the areas close to the river, it would be prudent for soil sampling for ASS to be undertaken beforehand and for abstracted groundwater to be monitored and/or treated before discharge.

2.2.5 Phosphorus Retention Index

Soil samples were taken from a depth of 0.5m in the infiltration test holes and other sites (Figure 4) and analysed for phosphorus retention index (PRI).

PRI is a measure of the ability of a soil to adsorb and retain phosphorus from solution. A high PRI indicates that a soil is unlikely to leach phosphorus to the water table. Typical ranges for PRI values in soils are as follows:

| <i>PRI Range</i> | <i>Rating</i> | <i>Typical soils</i> |
|------------------|-----------------|-----------------------------|
| 0 – 0.5 | Very Low | Bassendean Sand |
| 2 – 4 | Low – Moderate | Karrakatta Sands |
| 5 – 12 | Moderate – High | Cottesloe Sands |
| 12 – 20 | High | Crushed Limestone, Limesand |
| 20 – 1000+ | Very High | Clay |

The Department of Water advocates a minimum PRI of 15 for soils beneath infiltration basins.

Table 2.3 shows the PRI values obtained from the on-site samples. The values are all moderately high to very high, with some extremely high values. In practical terms, these high PRI values will be of little significance due to the very low permeability of the soils, which will prevent their being used as the base for infiltration basins. Materials imported for lining the basins will need to at least meet the DoW's preferred minimum PRI of 15.

Table 2.3 Soil PRI Results

| <i>Sample Location (see Figure 4)</i> | <i>Phosphorus Retention Index (PRI)</i> |
|---|---|
| K11 | 33 |
| K12b | 10 |
| K12c | 34 |
| K13 | 74 |
| K14 | 8,502 |
| K15 | 11,509 |
| K16 | 2,043 |
| K17 | 65,313 |

2.3 Hydrology

2.3.1 Surface Drainage

The low-permeability soils of the project area mean that most drainage is by surface runoff. There are no defined natural surface drainage channels within the subject land, with runoff generally occurring by overland sheet flow. The higher parts of the project area, furthest from the Canning River, are generally well drained. The sloping areas closer to the river are subject to seepage and saturation in parts. Most of these are outside the development area.

One constructed drainage line flows within a 5m wide Council easement near the southern boundary of Lot 22 (the aged person's home site), carrying street drainage from a catchment east of the project area into the river. This drainage is piped from Clifton St to about 110m south-west, from where it continues as an excavated surface drain to the river.

Runoff from private lots within the project area currently flows overland to the river. The aged care facility on Lot 22 has its own detention basin located in the south-western part of the lot, with a high-level overflow into the council drain.

The major surface drainage feature of the project area is the Canning River and its floodplain, which forms the western boundary of the development area. Figure 5 shows the alignment of the river and the boundaries of its 100-year floodway and flood fringe. No development of lots is proposed within the floodway.

The Canning River and its immediate foreshore are covered by a Development Control Area (DCA) under the *Swan and Canning Rivers Management Act 2006*. The DCA forms the western boundary but does not cover any part of the structure plan area.

2.3.2 Groundwater

Groundwater Occurrence and Flows

Groundwater exists in the clay soils beneath the project area and flows south-west towards the river. The clay soils over most of the site suggest that the rate of groundwater movement is very low. A sand lens in the south of Lot 25 and possibly extending into Lot 26 would permit more rapid groundwater movement in that area.

Groundwater surfaces as seepage in winter along parts of the face of the slope on the edge of the floodway, creating surface saturation in these areas. An indication of the areas susceptible to saturation (based on site inspection in September 2014) is shown on Figure 5.

Depths to groundwater measured at the end of September 2014 ranged from nearly six metres in the north-east corner of Lot 20 to less than one metre in the south-east of Lot 25. The shallow groundwater occurred in a sand lens and is likely perched on the underlying clay. This is supported by subsequent measurement in December 2015, which showed a groundwater level at this location nearly 3m below the September 2014 level. Table 2.4 shows the measured groundwater depths and levels. Figure 5 shows inferred groundwater contours based on the September 2014 bore readings.

Table 2.4 Groundwater Levels

| Bore (see Figure 5) | 26/09/2014 | | 16/12/15 | |
|---------------------|--------------------|--------------------|--------------------|--------------------|
| | Water Depth (mbgl) | Water Level (mAHD) | Water Depth (mbgl) | Water Level (mAHD) |
| KB1 | 5.28 | 18.52 | 6.93 | 16.87 |
| KB2 | 1.95 | 16.85 | 2.94 | 15.87 |
| KB3 | 0.79 | 25.71 | >3.75 | <22.75 |
| KB4 | 1.25 | 16.95 | 1.52 | 16.69 |

Water Resources

The project area is not within any proclaimed groundwater area and groundwater abstraction is not currently subject to licensing by the DoW. Two production bores owned by the City of Armadale are located in the north-east and south-west of Lot 20. These bores both draw from the superficial aquifer (depth unknown) and are used to irrigate Public Open Space including Frye Park.

Existing landowners within the project area have river frontage and have historically drawn water for irrigation direct from the river. This access will cease when the lots are subdivided and the foreshore is ceded as Regional Open Space.

2.3.3 Wetlands

There are no wetlands within or close to the project area except for the watercourse of the Canning River, which is mapped by the DPAW as Conservation Category River and Palusplain. Figure 5 shows the DPAW wetland mapping.

Because it is a waterway, foreshore setbacks to the river are determined by the WAPC and DoW with reference to Development Control Policy DC3.1 and the biophysical assessment that was undertaken prior to the 2009 MRS Amendment in accordance with DoW publications including *River Restoration 16*.

2.4 Water Quality

Water samples were collected on 26 September 2014 and 16 December 2015 from four bores within the project area, as well as the Canning River upstream and downstream and the drain that enters through Lot 22. Table 2.5 shows the water analysis results.

Water quality sampling has previously been undertaken by the DoW at one location a short distance downstream of the project area. The DoW sampling location is shown on Figure 5 and the results of the monitoring are shown in Table 2.6.

The results in Table 2.5 show that the water quality is good across the site, with low levels of nutrients, metals and acid sulphate soil indicators. The high Total Phosphorus concentrations in KB1 and KB2 in September 2014 appear to be associated with the very high suspended solids loads in these samples; Reactive Phosphorus was low in these and the other bores. The levels of nutrients in the bores were generally slightly lower in December than in September.

The salinity varies across the site, with the lowest salinity being in the Canning River upstream of the project area. The relatively high salinity of the drain entering through Lot 22 may be responsible for the increased salinity of the river at the downstream end of the site.

The water quality in the river was generally better than that beneath the site, and was marginally better in December than in September. Both of these are normal. The water quality downstream of the site was of marginally lower quality than that upstream, most noticeably in September. This is likely due to the input of water from the drain entering through Lot 22, which carries untreated road runoff with elevated levels of nitrogen, phosphorus and salinity.

Comparison of the results in Table 2.5 with the DoW monitoring data in Table 2.6 shows that the water quality in the river in 2014 was similar to or slightly better than that in 2007.

Further sampling will be carried out prior to the preparation of Urban Water Management Plans for the subject land and reported in the UWMPs.

Table 2.5 Water Quality 2014 - 2015
(see Figure 5 for sampling locations)

| Parameter (all units mg/L unless stated otherwise) | Guide- line | 26/9/2014 | | | | | | | 16/12/2015 | | | | | | |
|--|----------------------|-----------|--------|--------|--------|--------|--------|--------|------------|--------|-----|--------|--------|--------|--------|
| | | KB1 | KB2 | KB3 | KB4 | KUS | KDS | KD | KB1 | KB2 | KB3 | KB4 | KUS | KDS | KD |
| Nutrients | | | | | | | | | | | | | | | |
| Total Nitrogen | 1.2 ² | 0.8 | 1.3 | 1 | 0.5 | 0.3 | 0.5 | 5.9 | 0.5 | <0.2 | ns | 0.3 | 0.2 | 0.2 | 2.1 |
| NOX | 0.15 ² | 0.29 | 0.02 | 0.21 | <0.01 | 0.27 | 0.31 | 5.4 | 0.22 | 0.08 | | 0.03 | 0.05 | 0.06 | 1.1 |
| Total Kjeldahl Nitrogen | ng | 0.5 | 1.3 | 0.8 | 0.5 | <0.2 | 0.2 | 0.5 | 0.3 | <0.2 | | 0.3 | 0.2 | <0.2 | 1 |
| Total Phosphorus | 0.065 ² | 7.8 | 7.2 | 0.26 | 0.41 | 0.17 | 0.16 | 0.2 | 1.7 | 0.25 | | 0.09 | 0.02 | 0.01 | 0.03 |
| Reactive Phosphorus | 0.04 ² | 0.06 | 0.05 | 0.05 | 0.03 | 0.01 | 0.01 | 0.02 | 0.03 | 0.04 | | 0.01 | <0.01 | <0.01 | 0.01 |
| Physico-chemical | | | | | | | | | | | | | | | |
| pH (no units) | 6.5-8.0 ² | 6.8 | 6.3 | 6.2 | 5.8 | 6.7 | 6.4 | 7.5 | 7.2 | 6.9 | | 6.7 | 7.6 | 7.5 | 8.1 |
| Conductivity (mS/cm) | 12-30 ² | 4 | 0.9 | 0.73 | 4.3 | 0.53 | 0.56 | 2 | 4.1 | 1.5 | | 1.4 | 0.69 | 0.79 | 2.8 |
| Salinity ¹ | 72-180 | 2400 | 540 | 438 | 2580 | 318 | 336 | 1200 | 2460 | 900 | | 840 | 414 | 474 | 1680 |
| Acidity (as CaCO ₃) | 40 ³ | 53 | 60 | 37 | 80 | 6 | 6 | 10 | 60 | 64 | | 60 | 11 | 6 | <5 |
| Alkalinity (as CaCO ₃) | ng | 250 | 130 | 98 | 95 | 45 | 54 | 170 | 240 | 150 | | 86 | 61 | 75 | 140 |
| Acidity:Alkalinity Ratio | 1 ³ | 0.21 | 0.46 | 0.38 | 0.84 | 0.13 | 0.11 | 0.06 | 0.25 | 0.4 | | 0.7 | 0.2 | 0.1 | <0.1 |
| Total Suspended Solids | ng | 1600 | 3600 | 13 | 31 | <5 | <5 | <5 | 680 | 63 | | 23 | <5 | <5 | 7 |
| Hardness | 60-350 ⁴ | 264 | 131 | 107 | 430 | 66 | 71 | 201 | | | | | | | |
| Ions | | | | | | | | | | | | | | | |
| Sulphate | ng | 120 | 17 | 21 | 140 | 27 | 29 | 100 | 130 | 22 | | 1 | 18 | 22 | 160 |
| Chloride | 350 ⁴ | 1000 | 190 | 150 | 1100 | 88 | 130 | 450 | 1300 | 380 | | 430 | 200 | 180 | 670 |
| SO ₄ :Cl Ratio | 0.5 ³ | 0.12 | 0.09 | 0.14 | 0.13 | 0.31 | 0.22 | 0.22 | 0.1 | 0.06 | | <0.01 | 0.09 | 0.12 | 0.24 |
| Metals | | | | | | | | | | | | | | | |
| Aluminium | 1 ³ | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.5 | <0.1 | | <0.1 | <0.1 | <0.1 | <0.1 |
| Arsenic (III & V) | 0.136 ² | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | <0.001 | <0.001 | <0.001 | <0.001 |
| Cadmium | 0.0004 ² | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | | <0.002 | <0.002 | <0.002 | <0.002 |
| Calcium | ng | 30 | 21 | 23 | 37 | 11 | 12 | 31 | 31 | 42 | | 11 | 19 | 22 | 46 |

| | | | | | | | | | | | | | | | |
|---------------|---------------------|------------|-------------|-------------|-------------|-------------|---------|------------|------------|---------|--|---------|---------|---------|------------|
| Chromium (VI) | 0.006 ² | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | | <0.002 | <0.002 | <0.002 | <0.002 |
| Copper | 0.0018 ² | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 |
| Iron | 10 ⁴ | <0.01 | <0.01 | 0.04 | 0.55 | 0.31 | 0.23 | 0.86 | <0.01 | <0.01 | | <0.01 | <0.01 | 0.03 | 0.06 |
| Lead | 0.0056 ² | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 |
| Magnesium | ng | 46 | 19 | 12 | 82 | 9.4 | 10 | 30 | 53 | 35 | | 23 | 7.4 | 8.5 | 39 |
| Mercury | 0.0019 ² | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Nickel | 0.0013 ² | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 |
| Potassium | ng | 13 | 2.3 | 7.1 | 13 | 2.6 | 2.8 | 8.5 | 7.4 | 3 | | 2.8 | 2.7 | 3.1 | 11 |
| Sodium | 230 ¹ | 740 | 120 | 97 | 750 | 74 | 76 | 420 | 750 | 190 | | 230 | 100 | 120 | 390 |
| Zinc | 0.015 ² | <0.01 | 0.02 | 0.05 | 0.08 | 0.02 | <0.01 | <0.01 | <0.01 | 0.01 | | <0.01 | <0.01 | <0.01 | <0.01 |

1. Calculated as 600 x recorded electrical conductivity (mS/cm).

2. ANZECC (2000) Aquatic Ecosystem trigger values (Nutrient, pH and Conductivity are for lowland rivers; Dissolved Metals are for freshwater ecosystems (90% species protection))

3. DEC (20__) oxidation indicator triggers for ASS-affected groundwater.

4. ANZECC (2000) Irrigation trigger values (long-term irrigation up to 100 years).

Table 2.6 Canning River Upstream Water Quality 2007 (DoW)
(see Figure 5 for sampling location)

| | Guide- line | 20/6/2007 | 24/7/2007 | 7/8/2007 | 20/9/2007 | 3/10/2007 |
|------------------|----------------------|-----------|-----------|----------|-----------|-----------|
| TN | 1.2 ² | 0.3 | 0.92 | 1.1 | 0.81 | 0.76 |
| NOx | 0.15 ² | 0.062 | 0.43 | 0.88 | 0.57 | 0.48 |
| TKN | ng | 0.23 | 0.48 | 0.2 | 0.25 | 0.28 |
| TP | 0.085 ² | 0.01 | 0.051 | 0.026 | 0.015 | 0.009 |
| FRP | 0.04 ² | 0.005 | 0.005 | <0.005 | <0.005 | <0.005 |
| pH | 6.5-8.0 ² | 7.16 | 7.41 | 7.47 | 7.9 | 7.45 |
| Conductivity | 12-30 ² | 0.41 | 0.41 | 0.43 | 0.45 | 0.50 |
| Salinity | 72-180 | 190 | 200 | 200 | 210 | 240 |
| TSS | ng | 1 | 42 | 13 | 6 | 5 |
| Hardness | 60-350 ⁴ | 46 | 50 | 56 | 61 | 65 |
| Aluminium | 1 ³ | 0.11 | | 0.78 | 0.18 | 0.12 |
| Arsenic (total) | 0.136 ² | <0.001 | | <0.001 | <0.001 | <0.001 |
| Cadmium | 0.0004 ² | <0.0001 | | <0.0001 | <0.0001 | 0.0004 |
| Chromium (total) | 0.006 ² | <0.001 | | 0.001 | <0.001 | <0.001 |
| Copper | 0.0018 ² | <0.001 | | 0.002 | 0.001 | 0.002 |
| Iron | 10 ⁴ | 0.41 | | 1.3 | 0.79 | 0.86 |
| Lead | 0.0056 ² | <0.001 | | 0.001 | <0.001 | <0.001 |
| Mercury | 0.0019 ² | <0.0001 | | 0.0001 | <0.0001 | <0.0001 |
| Nickel | 0.0013 ² | <0.001 | 0.002 | <0.001 | <0.001 | <0.001 |
| Zinc | 0.015 ² | 0.002 | 0.018 | 0.011 | <0.001 | 0.003 |

2. ANZECC (2000) Aquatic Ecosystem trigger values (Nutrient, pH and Conductivity are for lowland rivers; Dissolved Metals are for freshwater ecosystems (90% species protection)).

3. DEC (20) oxidation indicator triggers for ASS-affected groundwater

4. ANZECC (2000) Irrigation trigger values (long-term irrigation up to 100 years).

2.5 Vegetation

The development area is largely cleared of native vegetation. On the western side, on the edge of the floodway, are a number of mature Flooded Gum (*Eucalyptus rudis*). More Flooded Gums occur in the floodway and the river channel. These areas and their native vegetation will be protected within the foreshore reserve and local POS following the redevelopment of the site.

Over the rest of the development area the cover consists mainly of introduced trees (including exotics and non-local natives) and grasses.

The large Flooded Gums in the floodway may contain hollows suitable for nesting of birds, although none were observed during the site surveys.

No Threatened Ecological Communities or Declared Rare or Priority listed flora were found during the site surveys.

The waterway and parts of the floodplain of the Canning River are within Bush Forever Site 246: "Southern Rivers, Beckenham to Martin/Kelmscott". The Bush Forever site is entirely contained within the foreshore reserve and local POS. Figure 4 shows the boundary of the Bush Forever site.

2.6 Land Uses and Potential Contamination

Historical Landgate aerial photography of the project area (Figure 6) shows no evidence of contamination or contaminating land uses since at least 1953, the date of the earliest photography. The land does not appear to have been used for market gardening, intensive animal stocking or industry at any time. The current use and former zoning for rural-residential housing is not indicative of a high risk of contamination.

The site inspection in September 2014 found no visual or olfactory evidence of past or present contamination. Current land uses consist of occupied rural-residential dwellings and an aged persons housing complex.

The DER Contaminated Sites Database shows no known contaminated sites on or near the project area. It is concluded that no further investigation of contamination is necessary.

3.0 WATER USE SUSTAINABILITY

3.1 Water Efficiency Measures

3.1.1 Public Open Space

Waterwise Landscaping

Waterwise landscaping will be applied to public open space, street verges and other public areas to reduce irrigation requirements. Section 6.0 sets out the landscaping principles to be adopted.

Measures to be adopted include the following:

- Street trees will be watered by tanker for the first two summers after establishment. Thereafter they will be unirrigated. Street trees will be planted after the majority of buildings have been constructed so as to minimise the risk of damage to the trees by construction vehicles.
- Landscape plantings (including POS, road verges and swales) will be irrigated for the first two summers after establishment by tricklers. Short-term trickle irrigation may be supplied from scheme water or a bore. After two summers the irrigation will cease, although trickler lines will remain in place and available for use if replacement plantings are required for any reason.
- All landscaping within the POS will employ waterwise native plants that do not require ongoing irrigation. Irrigated turf within POS will be limited to the small POS in the north-east of the subject land.
- The open space adjacent to the foreshore reserve will be planted with drought-resistant local native species suited to the prevailing site conditions.
- Irrigation will be by means of large droplet emitters or trickle irrigation where applicable.
- Irrigation will be scheduled to encourage deep root growth during plant establishment, with application intervals progressively extended and eventually discontinued.
- Garden beds and landscaped areas will be mulched to minimise water loss.
- Soil wetting agents will be used as appropriate to maximise water penetration and reduce overall irrigation demand. Wetting agents will not be used in situations where they could be washed into the Canning River.

- Plantings will be kept dense and compact, as these areas are more efficient to irrigate than dispersed plantings.
- Groundwater for irrigation of the north-eastern POS area will be sourced from the existing City of Armadale bore in that POS.

3.1.2 Domestic Use

5 Star Plus Building Standards

In accordance with the *Building Code of Australia 2012*, new homes within the development will incorporate the following features:

- Minimum 4 stars WELS rated tap fittings, except bath outlets and garden taps.
- Minimum 3 stars WELS rated shower heads.
- Minimum 4 stars WELS rated dual-flush toilets.
- Covers on all private swimming pools.
- All internal hot water pipes installed and insulated in accordance with AS 3500:2003.
- Maximum run of pipe from hot water system to outlet will not exceed 20 metres length or 2 litres internal volume.

Rainwater Harvesting

The developers will provide information and/or incentives for lot purchasers to install rainwater tanks.

Waterwise Landscaping

The developers will provide information packs, consisting of brochures and other information published by the Water Corporation and other agencies, to lot purchasers advising them of waterwise garden strategies including soil management, mulching, plant species selection, irrigation and fertilisation. Ultimately, the developer can influence but not control individual lot owners' decisions on these matters.

Where front landscaping packages are provided, street trees will be planted during the landscaping works. In the absence of front landscaping packages, street trees will be planted after a majority of buildings have been constructed so as to minimise damage to the trees.

3.2 Wastewater Management

All lots in the subdivision will be deep-sewered. Greywater recycling may be implemented by individual lot owners. Any person wishing to install a greywater reuse system must lodge an Application to Construct or Install an Apparatus for the Treatment of Sewage with the City of Armadale.

4.0 STORMWATER MANAGEMENT STRATEGY

4.1 Principles and Objectives

The stormwater management strategy aims to comply with the principles and objectives for stormwater management identified in the *Stormwater Management Manual for WA* (DoW, 2004) and *Better Urban Water Management* (WAPC, 2008).

Nutrient concentrations and loads in water leaving the site will be managed to comply with the targets of the draft *Swan Canning Water Quality Improvement Plan* (SRT, 2009), as follows:

- Winter median TP concentration: 0.1 mg/L
- Winter median TN concentration: 1.0 mg/L
- Annual TP yield: 0.013 kg/ha
- Annual TN yield: 0.2 kg/ha.

4.2 Design Criteria

Table 4.1 summarises the design criteria applying to the subject land, drawn from the DoW's *Developing a Local Water Management Strategy* (2008) and the *Canning River Precinct Environmental Review* (Enviroworks, 2009), and indicates how these criteria will be met in the development.

Table 4.1 Design Criteria

| <i>Objective</i> | <i>Source</i> | <i>Criterion</i> | <i>Strategy</i> |
|--|--------------------|--|--|
| Potable water use | DoW (2008) | Minimise ex-house use. Target <100 KL/pp/yr water use 40-60 KL/pp/yr scheme water use. | Perth Residential Water Use Study (Water Corp, 2009) estimated average 56 KL/pp/yr in-house, 46 KL/pp/yr ex-house. Small lots, multiple/group dwellings will minimise ex-house (e.g. Irrigation) use. |
| Water quantity | DoW (2008) | Post-development discharge same as pre-development | 1 yr, 5 yr and 100 yr peak discharge will be the same after development (see Section 4.4, Appendix D). |
| Maintain post-development surface and ground water quality at or above pre-development | DoW (2008) | Manage contaminated sites. | No soil contamination is believed to be present. |
| | | Treat drainage as per Stormwater Management Manual for WA. | See drainage description Sections 4.3 - 4.5. |
| | | Swales should equal 2% of impervious catchment area | See Appendix D. |
| | | Treat subsoil drainage. | No subsoil drainage is currently proposed. If required, SSD will be drained to detention basins. |
| Insect minimisation | DoW (2008) | Drainage basins hold water for <96 hours between November and May | 1-yr ARI rain gardens will drain within 2 hrs. 100-yr ARI detention basins will drain within 6 hrs. See Section 4.4 and Appendix D. |
| Drainage design | Enviroworks (2009) | Minimise additional flood risk in the Canning River | Peak runoff from the development site in up to 100 year ARI storms will be unchanged (see Section 4.3). |
| | | Maintain or improve water quality of drainage to the Canning River | Runoff up to 1 year ARI will be infiltrated, capturing over 98% of total flows (Section 4.3). |
| | | Minimise pollutant generation, disconnect drainage, treat runoff | As above. All ground surface runoff captured and treated by infiltration or detention. Clean roof runoff will be detained (option to bypass directly to river). |
| | | Soil amendment of lawns and gardens | Soil amendment is not necessary as the clay soils already have a very high phosphorus retention index (PRI). |
| Best Management Practices | Enviroworks (2009) | Rainwater harvesting | Information and/or incentives will be provided to purchasers regarding purchasing |
| | | Infiltration | See Section 4.4. |
| | | Pervious paving | Not feasible due to clay soils. |
| | | Gross pollutant traps (GPTs) | Not required due to small catchment size. |
| | | Swales | Potential to be examined at detailed design (UWMP) stage. |
| | | Bioretention | Incorporated in rain gardens and detention basins. |

| | | | |
|------------|--------------------|-------------------------|---|
| | | Revegetation | Proposed in POS and foreshore reserve. |
| | | Living streams | Proposed for detention basin overflows. |
| | | Constructed wetlands | Not proposed. |
| | | Detention and retention | See Sections 4.3 – 4.4, Appendix D. |
| Monitoring | Enviroworks (2009) | Pre-development | Groundwater depth and quality September 2014, December 2015 Groundwater depth planned for winter 2016. DoW river water quality data 2007. |
| | | Post-development | Each developer to monitor for 2 years after completion of subdivision. |

4.3 Drainage Management System

The drainage system will be designed to maintain surface flow rates within and from the developed site at or below their pre-development levels, unless further investigation shows that increasing flows to the Canning River is desirable. The drainage design presented here is conceptual and will be refined during the detailed design stage for each stage of subdivision and reported in the UWMP for that stage.

The drainage design of the subject land is constrained by a number of factors including:

- the presence of impermeable silty clay soils, which make dispersed local infiltration difficult or impractical;
- the moderately steep slopes on the western edge of the development area, which restrict options for location of infiltration basins and increase the risk of erosion;
- the design of the development, which aims (in line with State and local government policy for city centre areas) for increased development density, including smaller lots and narrower road reserves;
- the presence of the Canning River and its floodplain on the edge of the development.

The preliminary drainage design described in this LWMS is intended as a proof of concept to demonstrate that the site can be effectively drained. The system described here is essentially a traditional “pit and pipe” system, with runoff conveyed by pipes to infiltration and detention basins located in the foreshore POS. The drainage calculations and diagrams (e.g. Section 4.4, Figures 7-9, Appendices D & E) are based on this preliminary design.

The calculations show that the preliminary design is capable of effectively draining the site and managing flow rates and volumes to match the pre-development hydrology. Furthermore, by infiltrating all runoff from up to the 1-year ARI 1-hour storm, the system can intercept and remove virtually all sediment and other pollutants including metals, hydrocarbons and nutrients (particularly phosphorus) from the runoff before it reaches the river.

A number of alternative designs exist that have the potential to reduce the reliance on piped drainage. These include:

- replacement of some or all piped drainage and/or infiltration basins with vegetated swales in medians or road verges;
- increased in-lot storage of roof runoff;
- increasing flow rates to the Canning River.

These alternatives were considered during the preliminary drainage design phase but were found to be constrained by the site characteristics. They will require further examination during the detailed design of each stage of subdivision before they can be considered for adoption in place of, or as well as, the preliminary design.

The potential advantages and disadvantages of each of these alternatives are summarised in Table 4.2.

Table 4.2 Drainage Alternatives

| <i>Option</i> | <i>Advantages</i> | <i>Disadvantages</i> |
|---|---|---|
| Local Infiltration in median swales | At-source infiltration. Reduced pipe drainage. Reduced flows in small storms. | No medians available in internal roads. No infiltration in natural soils, requiring engineered swales with extensive subsoil drainage. |
| Local infiltration in verge swales | At-source infiltration. Reduced pipe drainage. Reduced flows in small storms. | Verges with lot frontages require frequent culverted crossovers. Landowners may fill or obstruct swales. Increased maintenance burden for Council. |
| Conveyance in non-frontage verge swales | Reduced pipe drainage. Reduced flow rates in small storms. | Constrained by road reserve widths and underground services. Increased maintenance burden for Council. Further investigation required. |
| In-lot detention of roof runoff | Reduced flow rates (not volumes) to street drainage. | No infiltration available on most lots – detention only. Increased cost and complexity of lot development. Only practical where pipe drainage connection is available. |
| Increased flow rates to Canning River | Increased flows in Canning River from small storms. Possible reduction in size of detention basins. | No increase in flow volume to Canning River, only rate. Increased risk of erosion/scouring in overflows and river. Further investigation required to assess impact on river flood levels. |
| Direct roof connection to overflow to river | Increased flows of clean water to river from small storms. Possible reduction in size of detention basins. | Separate dedicated pipe network required. Increased cost and complexity of development. Potential direct path for pollutants to river if misused (e.g. chemical disposal into downpipes). |

The redevelopment of the study area for housing at R40 density or higher will decrease the overall permeability of the site and give rise to higher local runoff rates and volumes. The silty clay soils that underlie the development area will limit the potential for local infiltration. For this reason, soakwells are unlikely to be feasible for capturing roof runoff on most private lots. The exception to this is the development fronting Clifton St south of Lucich St, where a requirement for filling to tie the lots into the Clifton St level will enable roof runoff to be infiltrated in soakwells within the fill. Other parts of the site may be filled (or excavated and backfilled) with sand, depending upon the site classification desired by individual developers. In these areas, soakwells may be practical for capturing roof runoff. For design and sizing purposes (see below), it has been assumed that no soakwells will be used. However, as noted in Table 4.2, the option exists to employ in-lot detention as a means of reducing flow rates to the pipe drainage system.

The site will be divided into three drainage catchments as shown on Figure 7. Roof runoff is expected to constitute up to 90% of the total runoff from lots. The option exists to route this clean water directly to the basin overflows, thus increasing flow rates to the Canning River from small storm events and reducing the load on the runoff treatment train. The desirability and feasibility of this option will be explored at the UWMP stage.

Runoff from paths, driveways and other paved areas within lots will be partly captured by garden beds and lawns, with larger flows overflowing to the road drainage system and into the treatment train.

Runoff from the roads and excess lot runoff will be captured and infiltrated in bioretention basins (rain gardens) located within POS areas in the west of each catchment (Figure 7). The rain gardens will be sized to contain and infiltrate the runoff from the first 15mm of each rainfall event (roughly equivalent to a 1-year ARI 1-hour event), in line with current DoW recommendations.

Figure 7 shows the preliminary drainage design based on piped conveyance of small flows to infiltration/detention basins in the POS. Figure 8 shows a possible alternative layout, with vegetated swales and pavement flow being used instead of pipes in some streets to convey runoff to the infiltration/detention basins. This and other alternatives will be examined further during the detailed design of each stage of subdivision.

Each rain garden will be surrounded by a detention basin designed to capture runoff from storms in excess of 1-year ARI up to 100-year ARI and release it at a controlled rate (not exceeding the pre-existing peak flow rate) into the Canning River. Figure 9 shows conceptual profiles of the rain gardens and detention basins.

The basin for Catchment 2 is located within the Canning River floodway on the site of an existing constructed pond. The Department of Water has advised (R. Bretnall, 2015 pers. comm.) that, because the basin will be constructed without any filling above existing ground levels and will therefore not obstruct flood flows, the Department has no objection to it being located in the floodway. The DoW's advice is attached in Appendix C.

Given the small size of Catchment 2, peak flows in storm events up to 100-year ARI will occur over a very short timescale in the order of 12–15 minutes (Appendix D). By contrast, major floods in the Canning River take about 48 hours to reach their peak (Middelmann *et al.*, 2005). For this reason, 100-year peak flows in Catchment 2 will not contribute significantly to flood flows in the Canning River. The Catchment 2 basin may be inundated by a 100-year flood in the Canning River; however, this would be of no significance in terms of the local catchment. Figure 10 shows a profile of the foreshore through the basin in Catchment 2.

It is expected that the existing drain within the easement on Lot 22 will remain in place in the medium term. Should Lot 22 be eventually redeveloped in line with the Structure Plan, the existing drain may be considered for realignment about 2.5m south-west into the proposed road reserve on the edge of Lot 22.

The capture and infiltration of 1-year ARI road runoff will tend to reduce the overall rate of discharge from the site in small storms. Because all runoff will ultimately enter the river, the volume of runoff from the site will not change significantly.

4.4 Basin Sizing and Design

The rain gardens will be sized to fully retain and infiltrate the runoff from the first 15mm of rainfall in each storm event (roughly equivalent to 1-year ARI, 1-hour duration), as recommended by the Department of Water (2016). This will ensure that approximately 99% of the total runoff from the site is captured and treated to remove entrained contaminants.

The detention basins will be sized to detain and compensate the runoff from storms up to 100-year ARI, in order to ensure that the peak flow rates from the site into the Canning River after development do not exceed the pre-development flow rates.

Appendix D presents details of the preliminary sizing of rain gardens and detention basins. Table 4.3 summarises the basin sizing. Appendix E shows event plans for the 1, 5 and 100 year ARI events as well as long sections of the drainage network. The runoff calculations and basin dimensions given here are preliminary and will be refined in the detailed drainage design prepared before subdivision.

Table 4.3 Preliminary Basin Sizing

| Catchment (Figure 7) | Area (ha) | Basin Water Depth (m) | | | Inundated Area (m ²) | | |
|-------------------------|--------------|-----------------------|------|--------|----------------------------------|------|--------|
| | | 1 yr | 5 yr | 100 yr | 1 yr | 5 yr | 100 yr |
| 1 | 2.65 | 0.23 | 0.9 | 1.2 | 321 | 532 | 610 |
| 2 | 1.79 | 0.24 | 0.86 | 1.15 | 182 | 383 | 491 |
| 3 | 1.03 | 0.40 | 0.76 | 1.01 | 156 | 244 | 317 |

The rain gardens will be engineered to ensure that they drain effectively while achieving a high rate of removal of sediments, particulate contaminants and dissolved nutrients. The rain gardens will be over-excavated into the natural soil then backfilled with an imported, permeable soil with a high phosphorus retention index (PRI). Suitable materials may include crushed laterite, limesand, crushed limestone or loam. The adsorptive material will be blended with topsoil if necessary to create a suitable growing medium for plants. The adsorptive layer will be underlain by a drainage layer such as crushed aggregate or gravel. Subsoil drains will be located within the drainage layer to capture infiltrating water and convey it to the discharge point.

The rain gardens and detention basins will be designed to be normally dry, with all captured water infiltrating or discharging within 96 hours in order to minimise the potential for insect breeding. With a maximum 1-year ARI water depth of 0.4m and a base permeability of 5 m/day, the rain gardens will drain from full in less than two hours. The detention basins will drain from the 100-year ARI full level in less than six hours. The rain gardens and detention basins will be densely planted with native species including sedges and small shrubs to promote uptake of nitrogen from the water.

4.5 Water Quality Management

The drainage system site will be designed to maximise on-site retention of nitrogen, phosphorus and other stormwater contaminants. This will be achieved by infiltrating all runoff from the first 15mm of rainfall in each storm (including approximately 99% of total flows) in densely vegetated rain gardens with a soil PRI of at least 15.

4.6 Maintenance

The drainage system has been designed to be low-maintenance. The following may be required to ensure that the stormwater drainage system continues to function as designed:

- Regular (possibly annual) cleaning of bubble-up pits, inlet pits and small culverts. More frequent cleaning may be required during the construction phase.
- Tending and maintenance of rain gardens and detention basins to remove litter, control weeds and encourage the growth of native species.

5.0 GROUNDWATER MANAGEMENT

5.1 Groundwater Levels

The proposed redevelopment of Lots 20-26 will have no significant effect on groundwater levels beneath the project area. Given the existing depth to groundwater, subsoil drainage will not be required for building with the possible exception of some small areas in the south-west where perched shallow groundwater and seepage are present (Figure 5). The need for subsoil drainage will be assessed during detailed design prior to subdivision and documented in the UWMP for this area. If subsoil drainage is required the subsoil drains will discharge into the bioretention basins, where treatment will occur.

Some short-term dewatering may be required for installation of underground services. If dewatering is required and is expected to exceed a rate of 10 litres/second, a total of 25,000 kilolitres or a duration of 30 days, the developer will apply to the Department of Water for an abstraction licence. Water produced by any dewatering operation will be held in a pond and used for dust suppression or infiltrated back into the ground as near as practical to the dewatering operation.

Landowners within the project area may install domestic bores for garden irrigation, although the density of the proposed development means that this is likely to be uncommon. Any domestic bores are likely to target deeper sand layers beneath the silty clay surface soils and are unlikely to have any effect on shallow groundwater levels.

No active management of groundwater levels by the City of Armadale is expected to be necessary, beyond monitoring of levels and yields in the existing POS irrigation bores.

5.2 Groundwater Quality

The bore sampling undertaken to date indicates that the groundwater beneath the site is generally of high quality, containing low concentrations of nitrogen, phosphorus and other contaminants.

The relationship between nutrient inputs and exports is complex, especially in the case of phosphorus, which travels through the soil profile as a “front” in a complex series of adsorption and desorption reactions. Nitrogen, also, is subject to denitrification and mineralisation in the soil and groundwater. As a result, nutrient exports from the site at present will be a reflection of nutrient inputs over the last several decades, modified by soil hydrology and nutrient retention capacity.

Development of the site is not expected to significantly change the quality of groundwater beneath the site. The main threats to water quality under urban development are lawn and garden fertilisers and road runoff. The contaminant of main

concern is phosphorus. The density of the proposed development means that lawn and garden areas will be limited.

The existing rural-residential dwellings on the site rely on on-site effluent disposal systems. The removal of these systems and their replacement with deep sewerage will remove this source of nutrient inputs to the groundwater.

The aim of nutrient management will be to limit nutrient inputs to the site so that nutrient exports are maintained at or below current levels. The primary source of groundwater-borne nutrients will be soluble garden fertilisers. With low-phosphorus garden fertilisers being strongly promoted under the State government's Fertiliser Action Plan, most fertilisers now available in retail stores contain little or no phosphorus.

Measures available to minimise nutrient inputs and exports in the development will include:

- regular street sweeping to remove accumulated contaminants;
 - selection of native species with low water and fertiliser requirements for public open space and landscaped areas;
 - community education on waterwise gardening, fertiliser use and management of pet wastes; and
 - modification of soils beneath the rain gardens if necessary to achieve a phosphorus retention index (PRI) of at least 15.
-

6.0 LANDSCAPE STRATEGY

Landscaping of public areas will focus on three areas:

- the Canning River foreshore reserve and adjacent POS;
- the small POS in the north-east corner of the project area; and
- street verges throughout the project area.

The north-eastern POS, measuring 1,123m², will be planted with about 700m² of irrigated grass. This will require about 470 KL/year of water, which is expected to be supplied from the existing City of Armadale bore located in the centre of this POS.

The river foreshore and adjacent POS will be rehabilitated and planted with native trees, shrubs and sedges that do not require ongoing irrigation beyond the initial establishment phase. The City of Armadale will maintain the landscaping following the ceding of the land to the Crown and after the initial developer maintenance periods.

The foreshore, adjacent POS and verge trees may, if necessary, be irrigated by tanker or temporary drip lines during the first two summers after establishment, although the clay soils of the site may make this irrigation unnecessary. If required, the water source for this irrigation may be the Water Corporation scheme or one of the existing City of Armadale bores in the project area. After two years this irrigation will cease but drip lines may be left in place in case needed for infill planting.

Fertiliser use in public areas will be minimal. Street trees will be fertilised with slow-release granular fertilisers on establishment and will thereafter not be fertilised. The small area of irrigated turf in the north-eastern POS will be fertilised with nitrogen and phosphorus on establishment and thereafter at a low rate with nitrogen alone. Phosphorus will only be applied if the turf shows signs of deficiency and only after soil or tissue testing.

Other water-saving landscaping to be adopted include the following:

- Irrigation will be by means of large droplet emitters or trickle irrigation where applicable.
 - Irrigation will be scheduled to encourage deep root growth during plant establishment, with application intervals progressively extended and eventually discontinued.
 - Garden beds and landscaped areas will be mulched to minimise water loss.
 - Soil wetting agents may be used as appropriate to maximise water penetration and reduce overall irrigation demand. Wetting agents will not be used in situations where they could be washed into the Canning River.
-

- Plantings will be kept dense and compact, as these areas are more efficient to irrigate than dispersed plantings.

Further details of water and nutrient management will be provided in Landscape Concept Plans that will be prepared prior to subdivision. Details of rehabilitation and landscaping in the foreshore area will be provided in the Foreshore Management Plan that will be required prior to any subdivision. The City of Armadale will assume responsibility for the management of the foreshore area following the ceding of this land to the Crown and completion of the initial developer maintenance periods, and will liaise with relevant government agency and community stakeholders in respect to ongoing management.

7.0 SUBDIVISION WORKS

Developers of land within the project area will implement a Construction Management Plan dealing with dust management, erosion and sediment control, containment of environmental hazardous materials (chiefly fuel and oils) and spill response. The key elements of the Construction Management Plan will include the following:

Dust Minimisation

- No topsoil stripping earthworks will be undertaken when the wind speed is greater than 25km/h.
- No earthworks will be undertaken when the wind speed is greater than 40km/h.
- Dust will be suppressed on open ground and stockpiles by regular watering, hydromulching, wind fencing and/or covering.
- An adequate supply of water for dust suppression will be kept on site at all times.
- Ground to be disturbed will be wet prior to soil disturbance.
- Soil stockpiles will be limited in height to minimise dust generation and to facilitate watering.
- Other dust minimisation measures will include minimising areas of disturbance, limiting volume and speed of construction traffic, and instructing site workers in dust minimisation.

Erosion and Sedimentation

- Drains and bunds will be constructed as necessary to capture and direct all runoff from disturbed areas into settling ponds prior to discharge.
- Drains, bunds and ponds will be appropriately designed and sized.
- Vehicles and machinery will be kept to designated roads, tracks and work areas.

Water Conservation

- Water consumption during construction will be minimised by:
 - limiting dust suppression watering to prevent ponding and runoff
 - use of non-water dust control methods such as wind fencing and hydromulching.

Hazardous Materials

- All environmentally hazardous materials will be stored in their original labelled containers (or labelled jerrycans in the case of petroleum fuels) in a ventilated sea container equipped with appropriate signage, fire extinguishers and a spill response kit.
- Petroleum products will be held in a bunded enclosure.
- Material Safety Data Sheets (MSDS) and a chemical register for all hazardous materials on the site will be maintained by the site supervisor in the site office.

Complaints Register

- The site supervisor will maintain a record of any public complaints and the actions taken in response.
-

8.0 MONITORING AND RESPONSE

8.1 Monitoring Programme

As the redevelopment of the project area is likely to be undertaken by a number of landowners and/or developers over a number of years a formal monitoring programme is inappropriate in this case. Instead, it is proposed that the parties to the redevelopment plan will monitor the groundwater and river for two years to establish a water quality baseline for the site. Thereafter, developers undertaking subdivision and development within the project area will conduct monitoring for two years after the completion of their developments.

The monitoring points will include or reflect those used for pre-development monitoring, as shown on Figure 5. Any bores that are lost or damaged during development works will be reinstalled or replaced.

Post-development water monitoring will be carried out twice each year in winter and spring, in accordance with the DoW (2012) *Water Monitoring Guidelines for Better Urban Water Management* (Appendix B, Table A2). The monitoring parameters will include:

- Depth to groundwater.
- Field parameters – temperature, pH, conductivity, salinity.
- Physical parameters – pH, TDS, TSS, hardness, acidity, alkalinity.
- Major ions – chloride, sulphate.
- Nutrients – Total P, FRP, Total N, TKN, NO_x.
- Metals – Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn.

8.2 Criteria

Trigger values for water quality will be developed based on ANZECC water quality standards, the monitoring results to date and further monitoring carried out before the preparation of the UWMP. The trigger values will be set to ensure that the water quality within and downstream of the site will be as good after development as before. The trigger values will be reviewed after each round of monitoring to confirm their applicability and to assess the need for any revision.

The basis for determining the trigger values will be as follows:

Bores

- Target
 - Median of bore values should not exceed the median of all pre-development bore values by more than 20%.
 - The median pH in the bores should be within 20% of the median of all pre-development bore values.

- **Limit** - No bore value should exceed twice the maximum of all pre-development bore values.

Canning River Downstream

- **Target** - Should not exceed the maximum of pre-development values for Canning River Downstream or Upstream, whichever is the higher, by more than 20%.
 - Should not exceed the value for Canning River Upstream on the same sampling occasion by more than 20%.
 - The pH in the Canning River Downstream should be within 20% of the median of all pre-development bore values and within 20% of the pH in the Canning River Upstream on the same sampling occasion.
- **Limit** - Should not exceed twice the maximum of pre-development values for Canning River Downstream or Upstream, whichever is the higher.

8.3 Contingency Response

The results of each round of water monitoring will be compared with the trigger values. If any water quality limit is breached, the developer will respond as follows:

1. Initially, resample to confirm that the breach was not due to sample contamination or natural variation.
 2. Inform the City of Armadale.
 3. Determine whether the breach is an isolated, project or regional occurrence.
 4. Determine whether the breach is attributable to the development or to external factors.
 5. Take appropriate contingency action(s) in consultation with the City of Armadale and the Department of Water. These may include:
 - Identify and remove any point sources of contamination.
 - Review operational and maintenance (e.g. fertiliser) practices.
 - Modify the stormwater system including enlarging or modifying bioretention basins.
 - Reinforce community education/awareness programs.
 6. Record the breach and the action taken.
 7. If necessary, inform residents of any required actions and their purpose.
-

8.4 Recording and Reporting

Developers will keep a record of the results of all monitoring, including any breaches of trigger values and actions taken. Any breaches of limits and contingency actions will be reported immediately to the City of Armadale.

At the end of the post-development maintenance period, developers will prepare a report to the City of Armadale containing all of the recorded data and records of any breaches of criteria and contingency actions taken.

9.0 IMPLEMENTATION AND FURTHER MANAGEMENT PLANS

Structure planning and subdivision of lots within the Clifton Street Precinct will be carried out in accordance with the general water management principles set out in this LWMS.

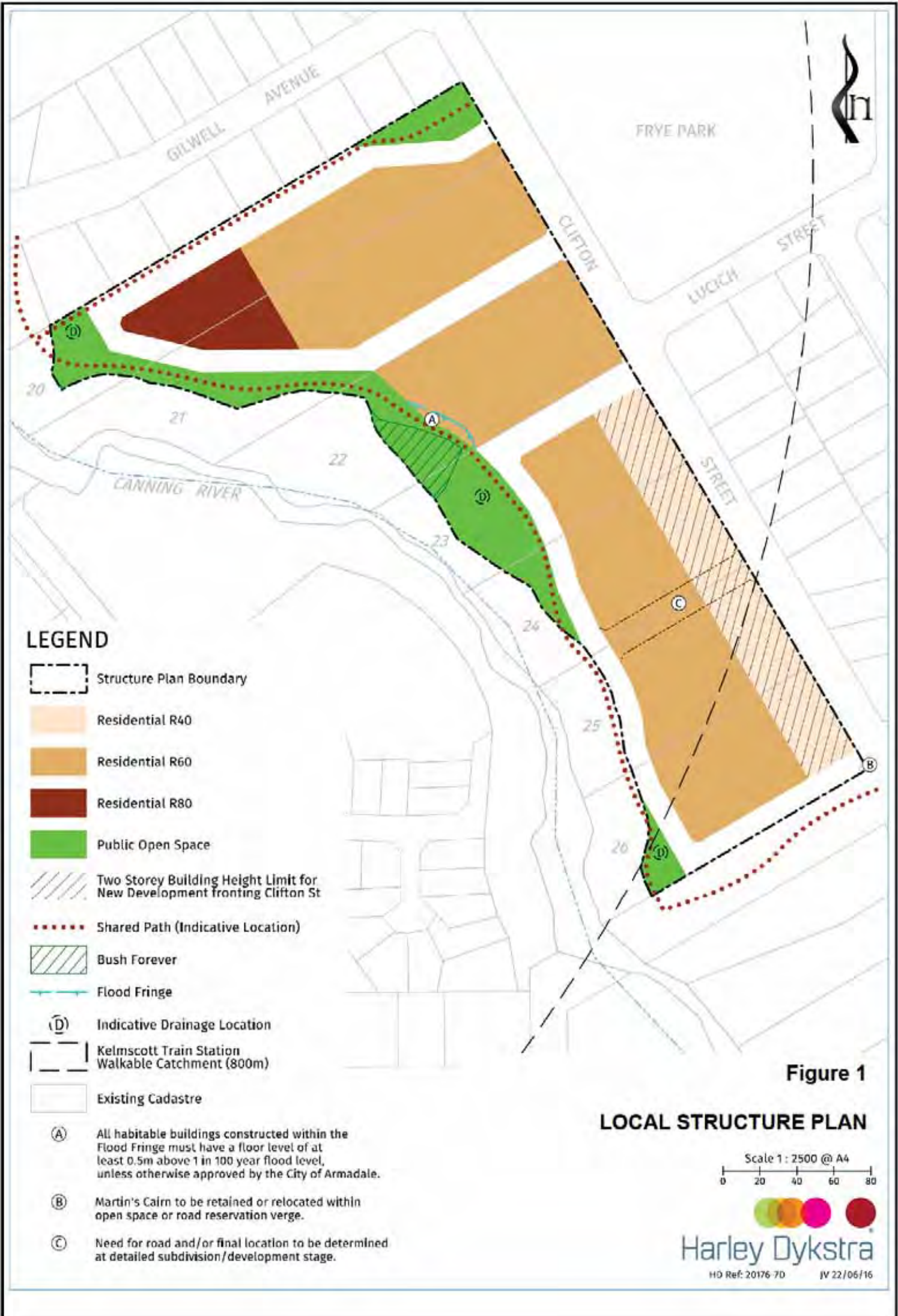
Urban Water Management Plans will be required for each stage of subdivision within the precinct. The UWMPs will contain detailed drainage designs, landscape plans and the results of further water monitoring.

Each developer will maintain the drainage system, landscaped areas and water monitoring program until two years after their subdivision is completed. At the end of that time the responsibility for monitoring and management will pass to the City of Armadale, subject to the City's acceptance of the works.

10.0 REFERENCES

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- WAPC (2004). *Liveable Neighbourhoods Edition 3*. WAPC, Perth.
- WAPC (2006). *State Planning Policy 2.9: Water Resources*. WAPC, Perth.
- WAPC (2008). *Better Urban Water Management*. WAPC, Perth.
- WAPC (2012). *Metropolitan Region Scheme Amendment 12032/41: Canning River Precinct, Kelmscott. Report on Submissions*. WAPC, Perth.

Figures



LEGEND

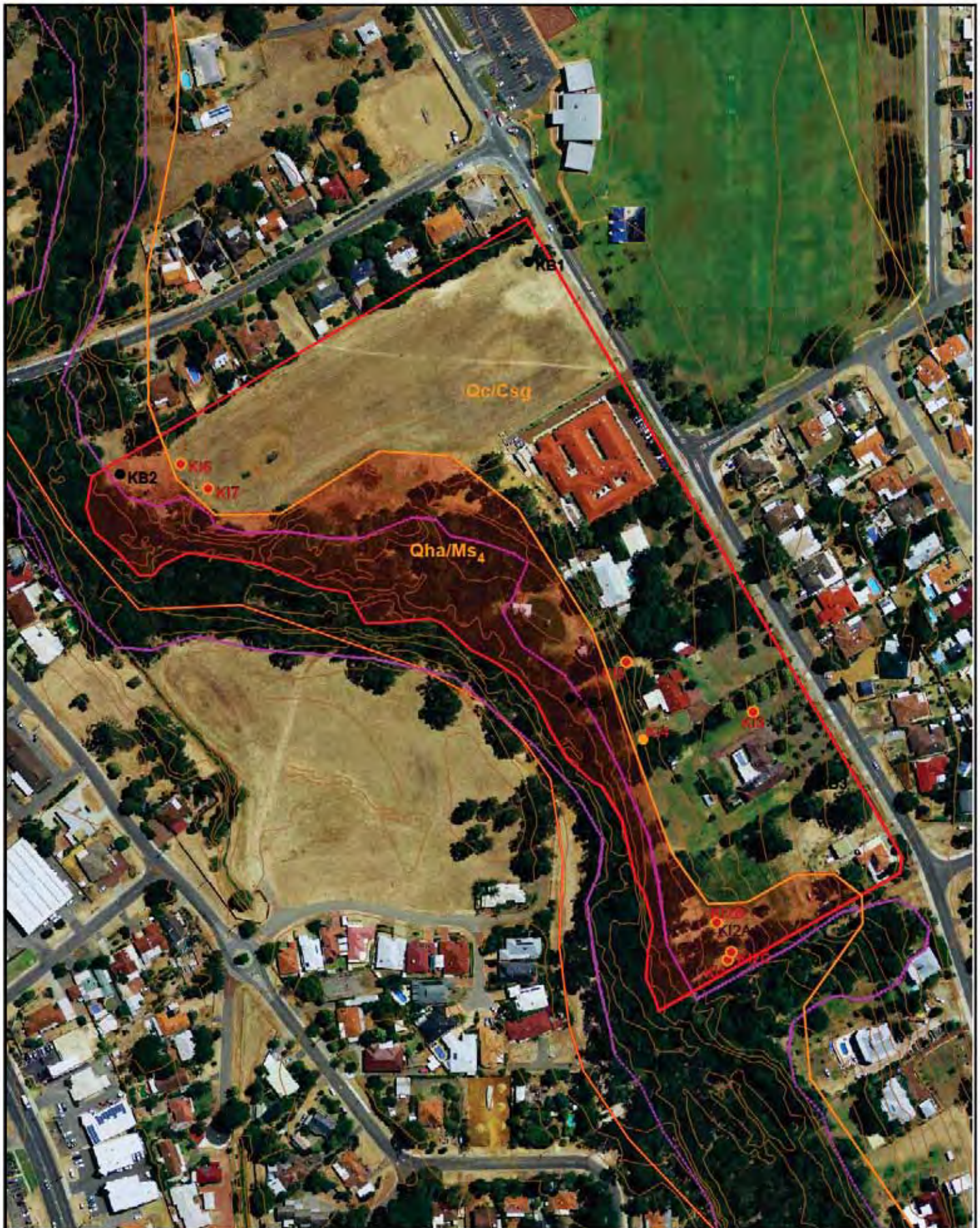
- Structure Plan Boundary
- Residential R40
- Residential R60
- Residential R80
- Public Open Space
- Two Storey Building Height Limit for New Development fronting Clifton St
- Shared Path (Indicative Location)
- Bush Forever
- Flood Fringe
- Indicative Drainage Location
- Kelmescott Train Station Walkable Catchment (800m)
- Existing Cadastre

- (A) All habitable buildings constructed within the Flood Fringe must have a floor level of at least 0.5m above 1 in 100 year flood level, unless otherwise approved by the City of Armadale.
- (B) Martin's Cairn to be retained or relocated within open space or road reservation verge.
- (C) Need for road and/or final location to be determined at detailed subdivision/development stage.

Figure 1

LOCAL STRUCTURE PLAN

Scale 1 : 2500 @ A4
 0 20 40 60 80



0 100 Meters

Figure 4

PHYSIOGRAPHY

- | | |
|--------------------------------|-------------------------|
| — Topographic contour (1m AHD) | — Project area boundary |
| — Geology (GSWA) | ● Borehole |
| — High ASS risk (DPAW) | ● Infiltration test |
| — Bush Forever Site 246 | ● PRI test |



0 80 Meters

- Floodway (DoW)
- Flood fringe (DoW)
- CCW (DPAW)

- Project area boundary
- Monitoring bore
- Surface water sample
- DoW river sample
- - - Groundwater contour 26/9/2014 (inferred)
- Saturated 26/9/2014

Figure 5

HYDROLOGY



1953

Figure 6a
HISTORICAL AERIAL
PHOTOGRAPHY



1965

Figure 6b
HISTORICAL AERIAL
PHOTOGRAPHY



1974

Figure 6c
HISTORICAL AERIAL
PHOTOGRAPHY



1981

Figure 6d
HISTORICAL AERIAL
PHOTOGRAPHY



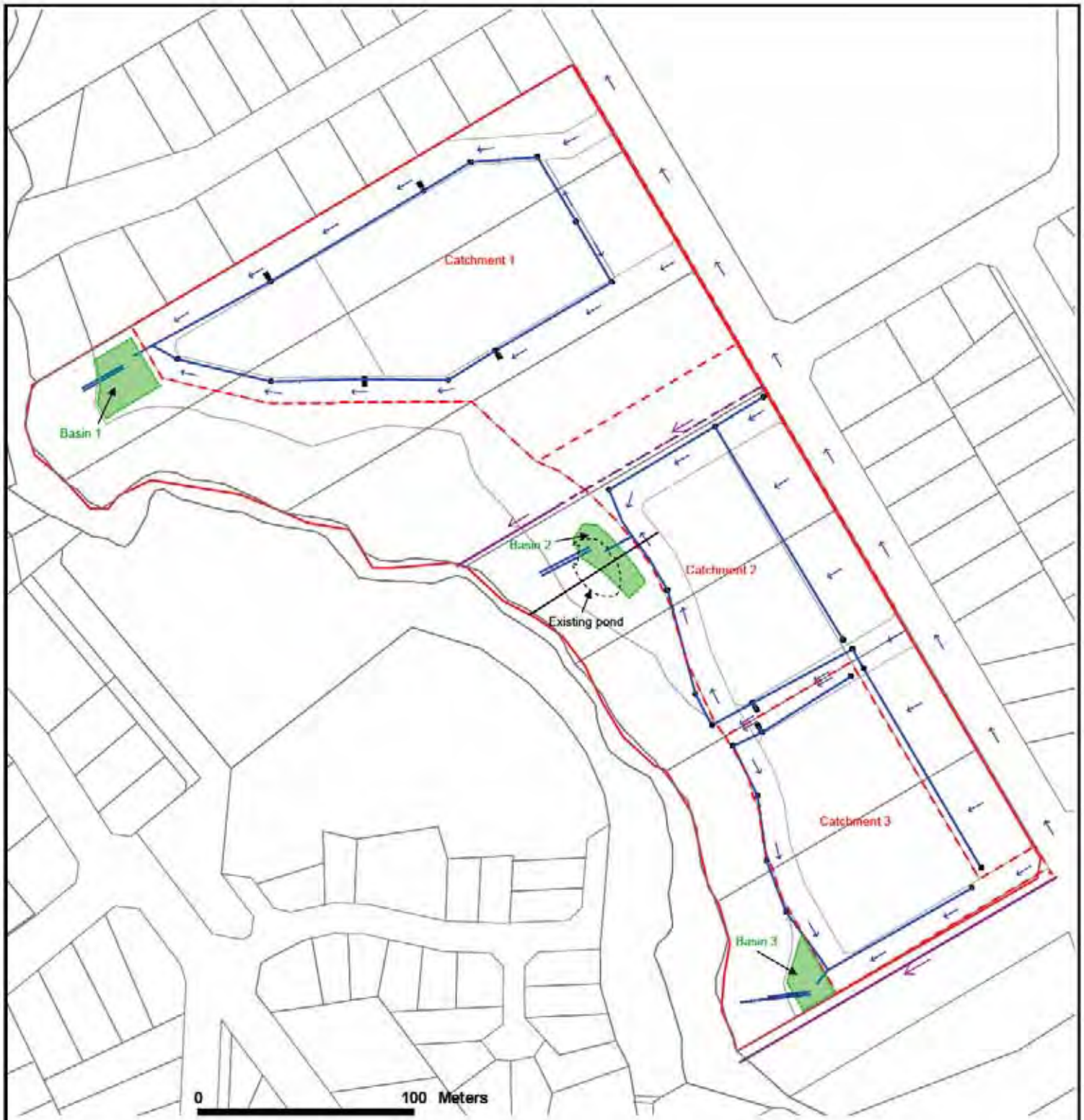
1995

Figure 6e
HISTORICAL AERIAL
PHOTOGRAPHY



2005

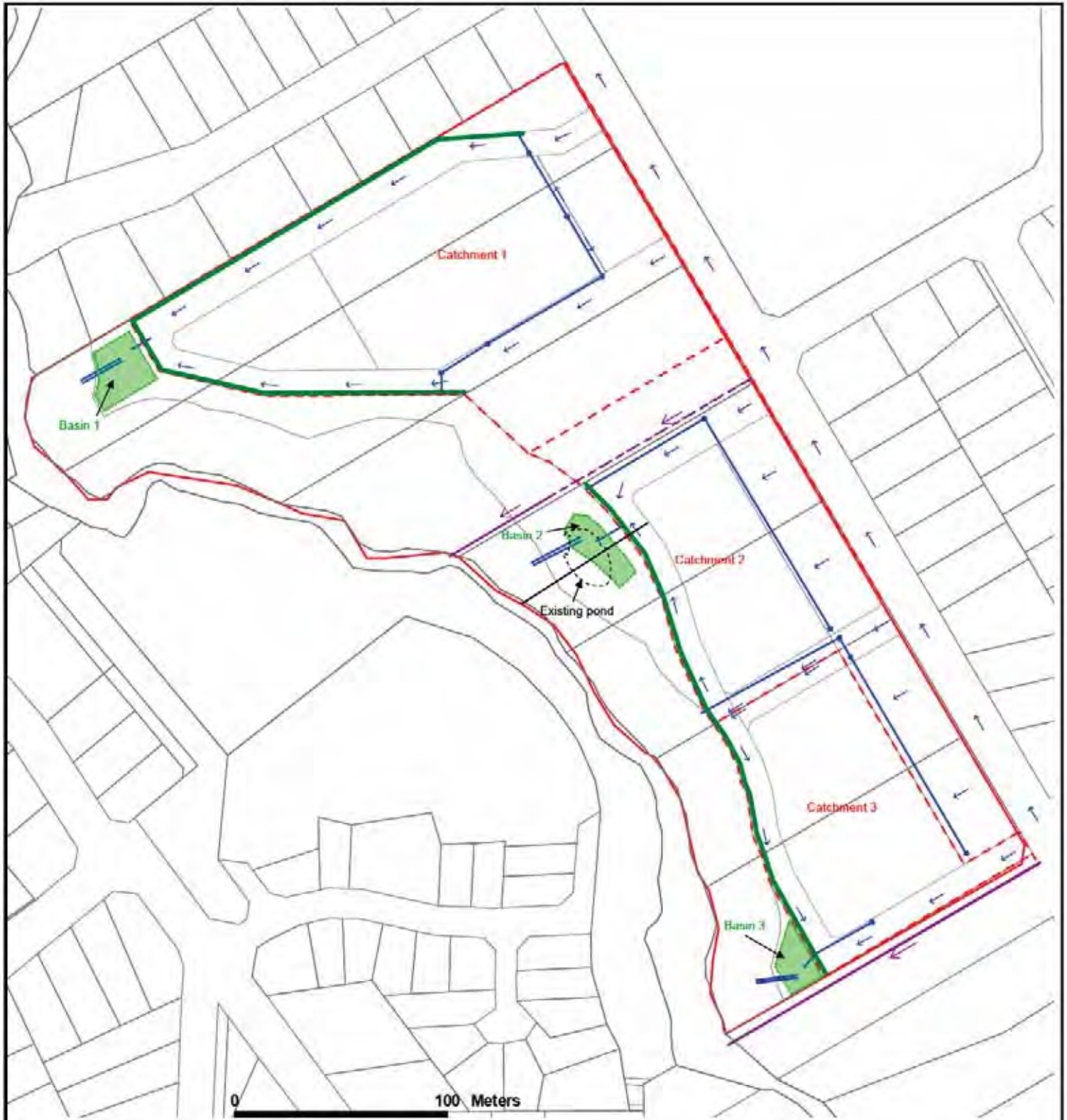
Figure 6f
HISTORICAL AERIAL
PHOTOGRAPHY



- Subject land boundary
- - - Catchment boundary
- - - Existing drain – surface/pipe
- Piped drainage
- ← Drainage direction
- Infiltration/Detention basin
- Basin overflow
- Foreshore profile (see Figure 10)

Figure 7

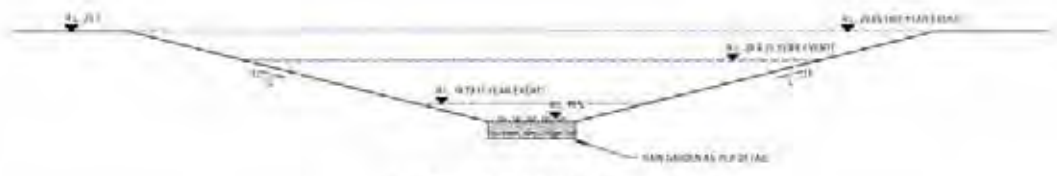
DRAINAGE CONCEPT



- Subject land boundary
- - - Catchment boundary
- - - Existing drain – surface/pipe
- Piped drainage
- Vegetated Swale
- ← Drainage direction
- ▨ Infiltration/Detention basin
- Basin overflow

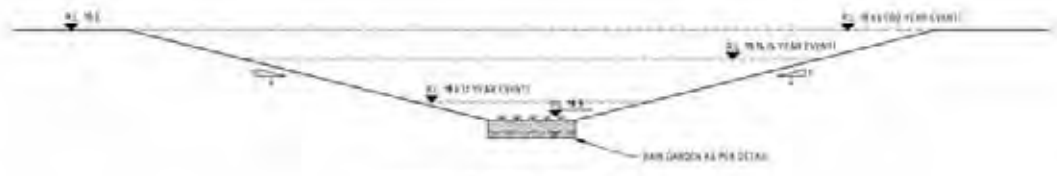
Figure 8

ALTERNATIVE DRAINAGE CONCEPT



TYPICAL BASIN 1 - SECTION
SCALE: N.T.S. **A**
203

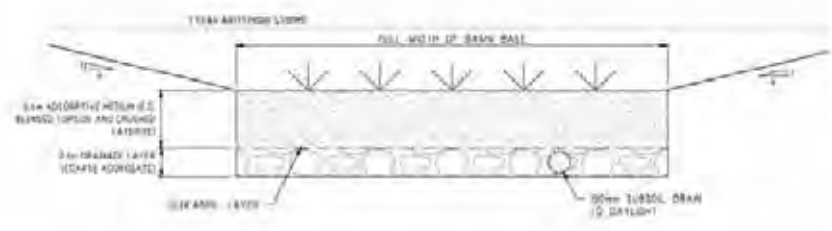
NOTE: EXISTING BASIN TO BE MODIFIED TO NEW DESIGN LEVELS



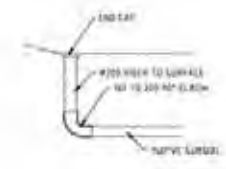
TYPICAL BASIN 2 - SECTION
SCALE: N.T.S. **B**
204



TYPICAL BASIN 3 - SECTION
SCALE: N.T.S. **C**
205



RAIN GARDEN DETAIL - CONCEPTUAL PROFILE
SCALE: 1/2"



SUBSOIL END DETAIL (IN BASIN BASE)
SCALE: N.T.S.

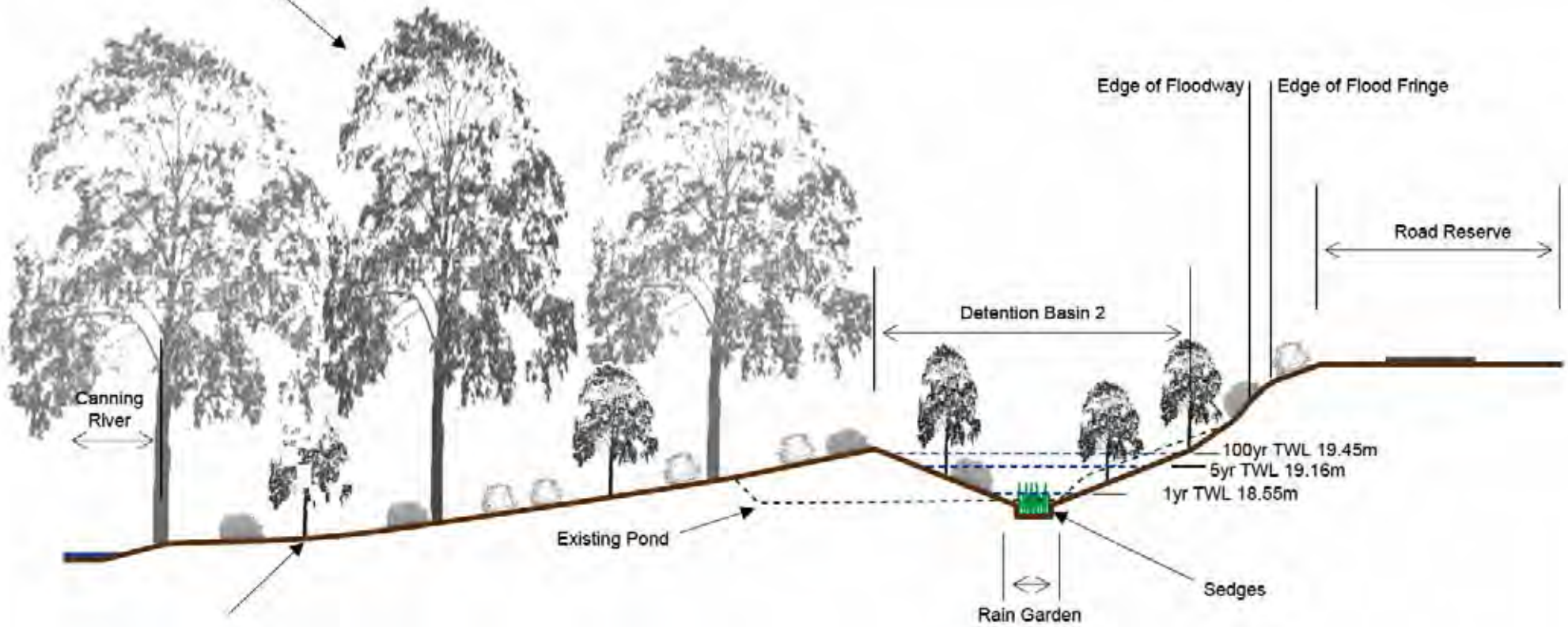


Figure 9

**RAIN GARDEN AND
BASIN DESIGN**



Existing Large Trees



Native Revegetation

0 20 metres

Vertical exaggeration: 2x

Figure 10

FORESHORE PROFILE

See Figure 7 for profile location

Appendix A

Bore Logs

SOIL PROFILE LOG

| | |
|-----------------------|------------|
| PROJECT NUMBER: | J12033 |
| SITE ID: | KB1 |
| EASTING: | 407 520 |
| NORTHING: | 6 446 587 |
| METHOD: | Auger Rig |
| TOTAL DEPTH (mbgl): | 8.8 |
| REFUSAL (Y/N): | N |
| DATE: | 19/09/2014 |
| DEPTH TO WATER (mbgl) | |

| SOIL PROFILE | | SAMPLE DATA | |
|--------------|---|-------------|--------------|
| DEPTH (m) | SOIL DESCRIPTION | SAMPLE ID | INTERVAL (m) |
| 0 - 0.5 | Dark brown gravelly silt, damp | | |
| 0.5 - 3 | Orange-brown silty clay, damp | | |
| 3 - 7 | Light brown silty clay, dry | | |
| 7-8.5 | Light brown silty clay, wet | | |
| 8.5 - 8.8 | White clay with weathered granite fragments | | |



SOIL PROFILE LOG

| | |
|-----------------------|------------|
| PROJECT NUMBER: | J12033 |
| SITE ID: | KB4 |
| EASTING: | 407 544 |
| NORTHING: | 6 446 335 |
| METHOD: | Auger Rig |
| TOTAL DEPTH (mbgl): | 4.5 |
| REFUSAL (Y/N): | N |
| DATE: | 19/09/2014 |
| DEPTH TO WATER (mbgl) | |

| SOIL PROFILE | | SAMPLE DATA | |
|--------------|---------------------|-------------|--------------|
| DEPTH (m) | SOIL DESCRIPTION | SAMPLE ID | INTERVAL (m) |
| 0 - 1 | Dark brown loam | | |
| 1 - 4.5 | Dark grey silt, wet | | |
| | | | |
| | | | |
| | | | |



Appendix B

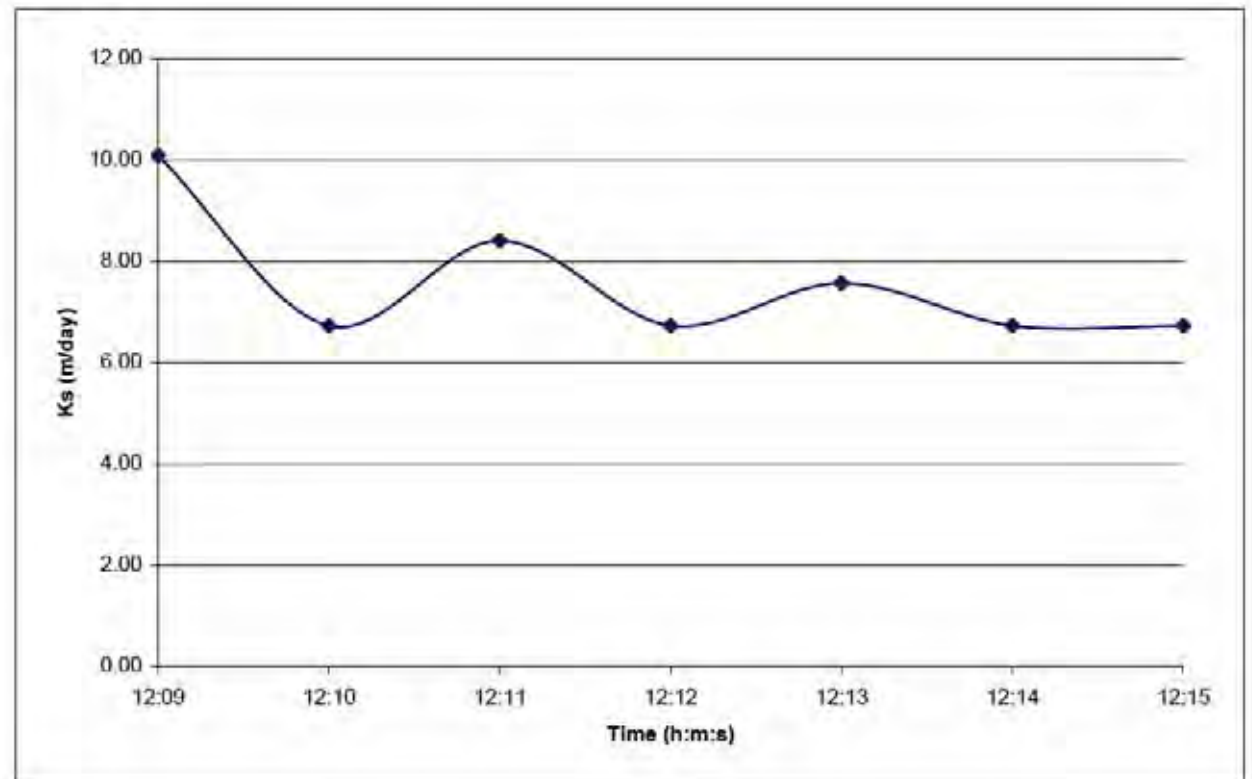
Permeability Test Results

SOIL PERMEABILITY TEST

| | |
|----------|-----------|
| Site No. | KI1 |
| Date | 5/11/14 |
| Easting | 407 639 |
| Northing | 6 446 192 |

| Time (h:m:s) | Weight (kg) | Change in Weight (kg) | Ks (m/d) |
|--------------|-------------|-----------------------|----------|
| 12:08:00 | 43 | | |
| 12:09:00 | 41.8 | 1.2 | 10.10 |
| 12:10:00 | 41 | 0.8 | 6.73 |
| 12:11:00 | 40 | 1 | 8.41 |
| 12:12:00 | 39.2 | 0.8 | 6.73 |
| 12:13:00 | 38.3 | 0.9 | 7.57 |
| 12:14:00 | 37.5 | 0.8 | 6.73 |
| 12:15:00 | 36.7 | 0.8 | 6.73 |

H = 25
r = 4.5

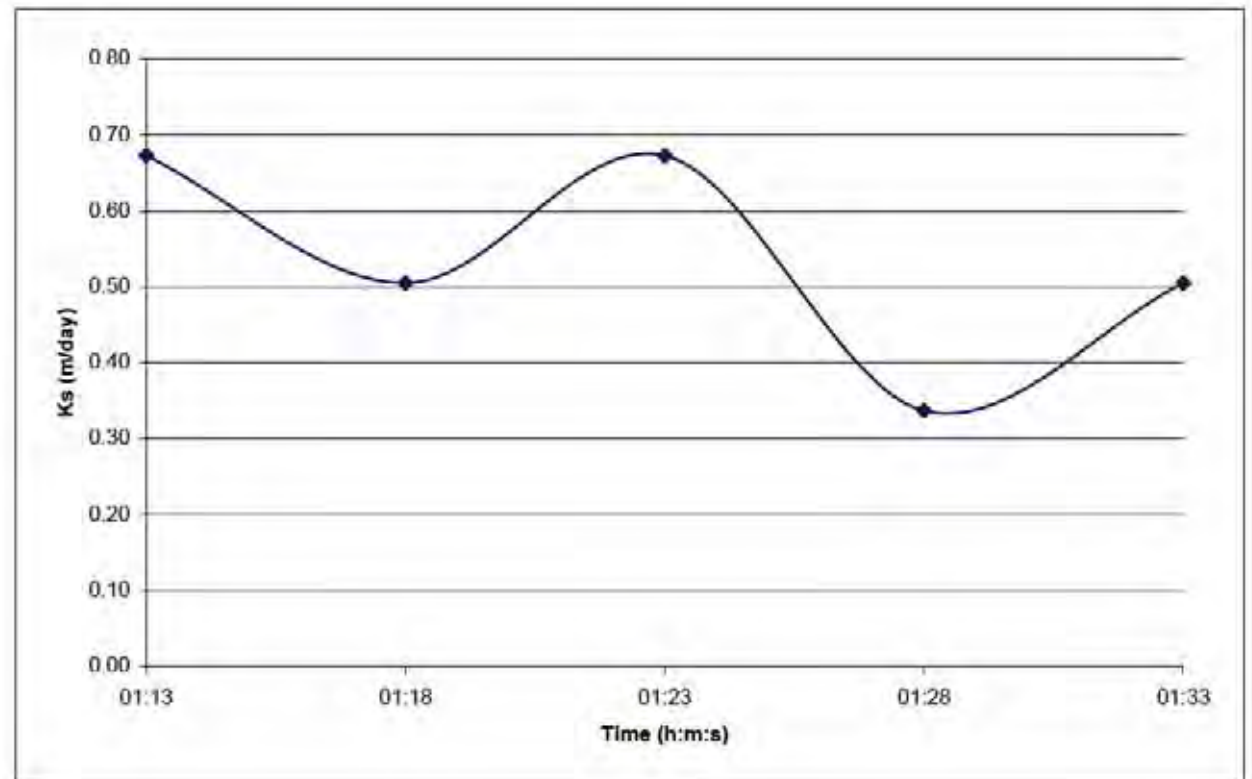


SOIL PERMEABILITY TEST

| | |
|----------|-----------|
| Site No. | K12b |
| Date | 5/11/14 |
| Easting | 407 629 |
| Northing | 6 446 206 |

| Time (h:m:s) | Weight (kg) | Change in Weight (kg) | Ks (m/d) |
|--------------|-------------|-----------------------|----------|
| 01:08:00 | 31.3 | | |
| 01:13:00 | 30.9 | 0.4 | 0.67 |
| 01:18:00 | 30.6 | 0.3 | 0.50 |
| 01:23:00 | 30.2 | 0.4 | 0.67 |
| 01:28:00 | 30 | 0.2 | 0.34 |
| 01:33:00 | 29.7 | 0.3 | 0.50 |

H = 25
r = 4.5

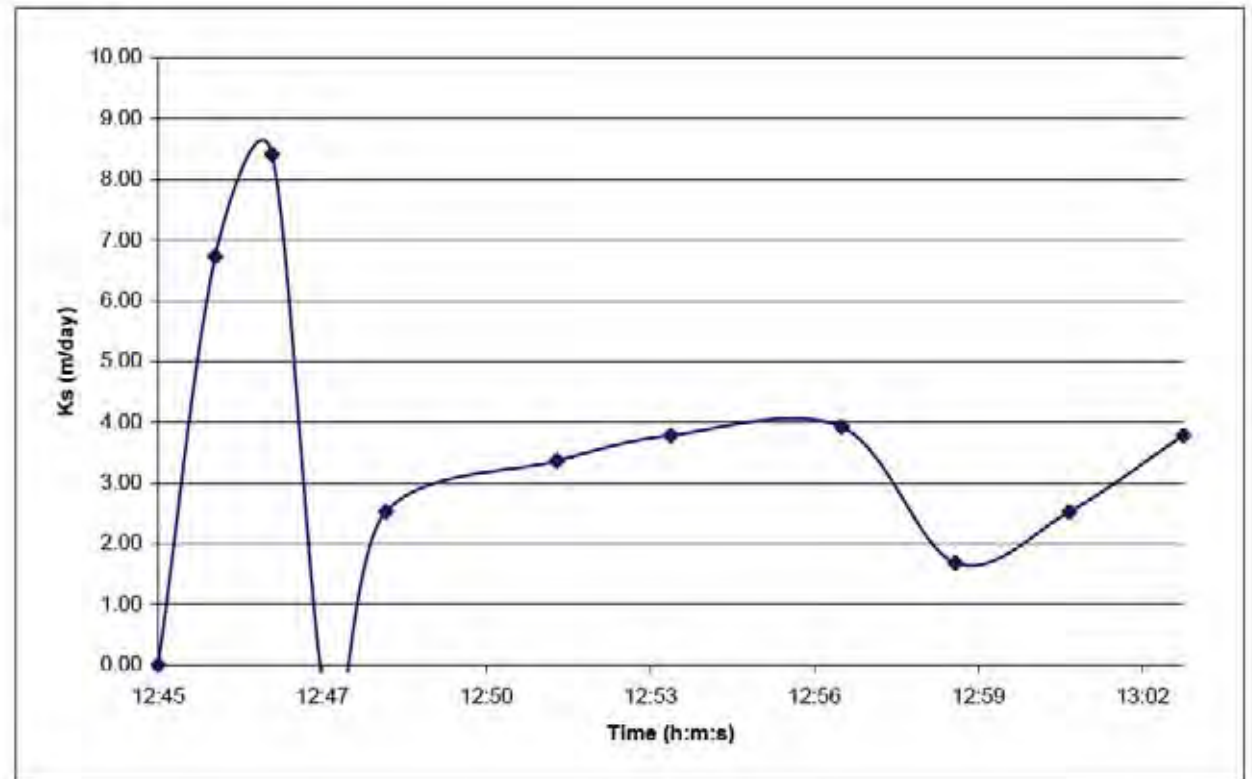


SOIL PERMEABILITY TEST

| | |
|----------|-----------|
| Site No. | K12c |
| Date | 5/11/14 |
| Easting | 407 637 |
| Northing | 6 446 184 |

| Time (h:m:s) | Weight (kg) | Change in Weight (kg) | Ks (m/d) |
|--------------|-------------|-----------------------|----------|
| 12:44:30 | 39.9 | | |
| 12:45:00 | 39.9 | | |
| 12:46:00 | 39.1 | 0.8 | 6.73 |
| 12:47:00 | 38.1 | 1 | 8.41 |
| 12:48:00 | 38.2 | -0.1 | -0.84 |
| 12:49:00 | 37.9 | 0.3 | 2.52 |
| 12:52:00 | 36.7 | 1.2 | 3.37 |
| 12:54:00 | 35.8 | 0.9 | 3.79 |
| 12:57:00 | 34.4 | 1.4 | 3.93 |
| 12:59:00 | 34 | 0.4 | 1.68 |
| 13:01:00 | 33.4 | 0.6 | 2.52 |
| 13:03:00 | 32.5 | 0.9 | 3.79 |

H = 25
r = 4.5

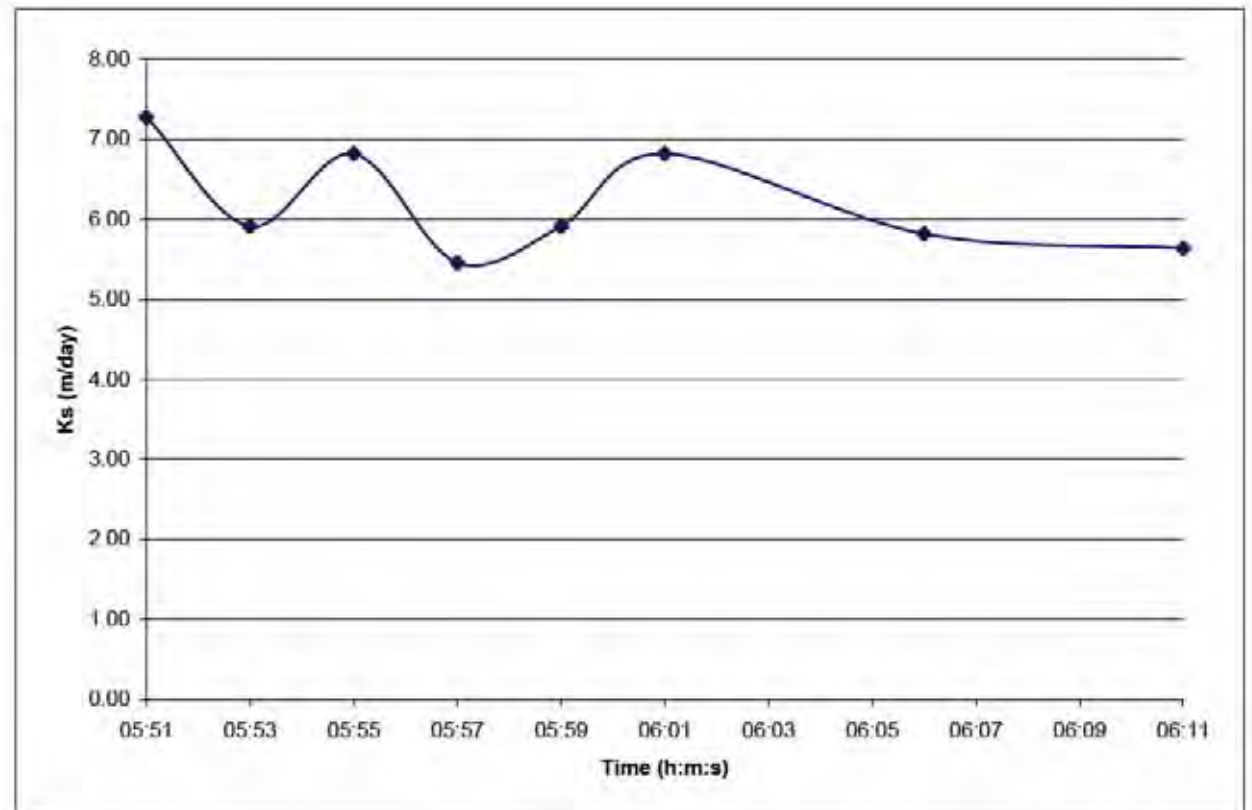


SOIL PERMEABILITY TEST

| | |
|----------|-----------|
| Site No. | KI6 |
| Date | 5/11/14 |
| Easting | 407 322 |
| Northing | 6 446 472 |

| Time (h:m:s) | Weight (kg) | Change in Weight (kg) | Ks (m/d) |
|--------------|-------------|-----------------------|----------|
| 05:49:00 | 25.4 | | |
| 05:51:00 | 23.8 | 1.6 | 7.28 |
| 05:53:00 | 22.5 | 1.3 | 5.91 |
| 05:55:00 | 21 | 1.5 | 6.82 |
| 05:57:00 | 19.8 | 1.2 | 5.46 |
| 05:59:00 | 18.5 | 1.3 | 5.91 |
| 06:01:00 | 17 | 1.5 | 6.82 |
| 06:06:00 | 13.8 | 3.2 | 5.82 |
| 06:11:00 | 10.7 | 3.1 | 5.64 |

H = 25
r = 4

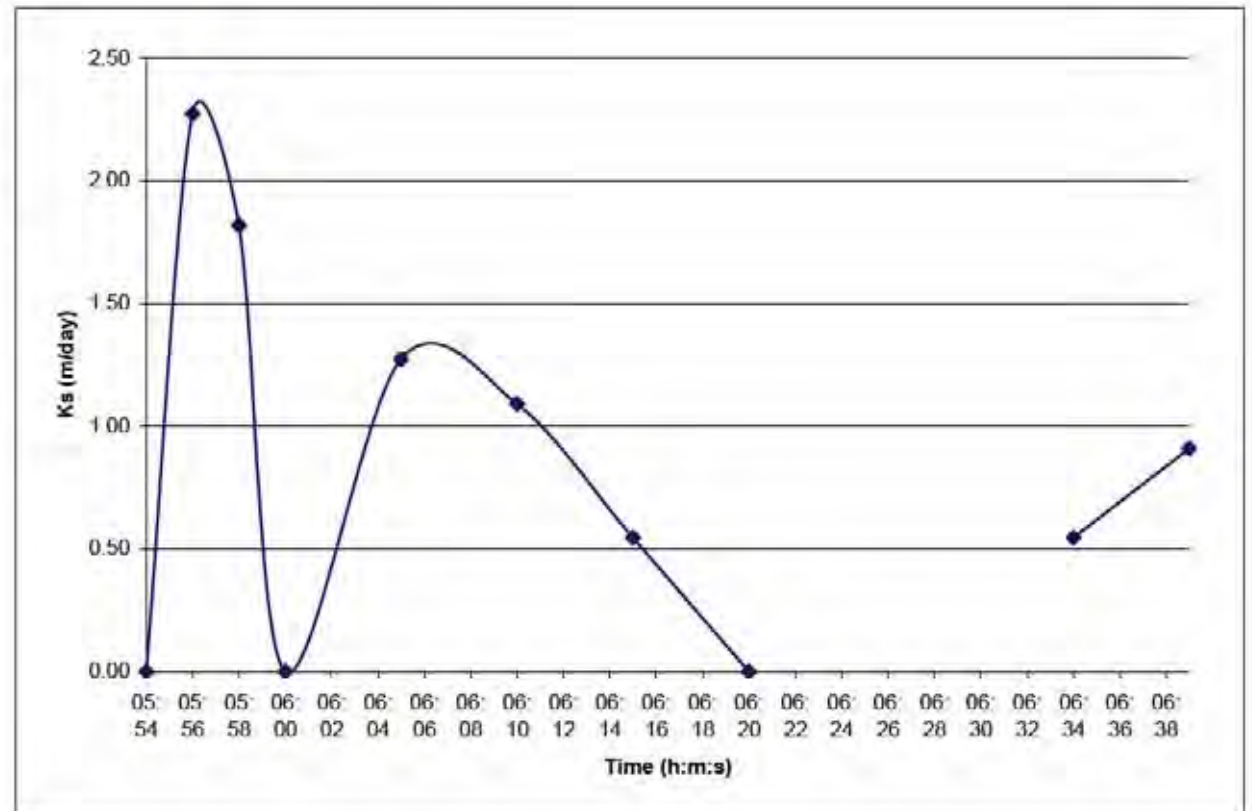


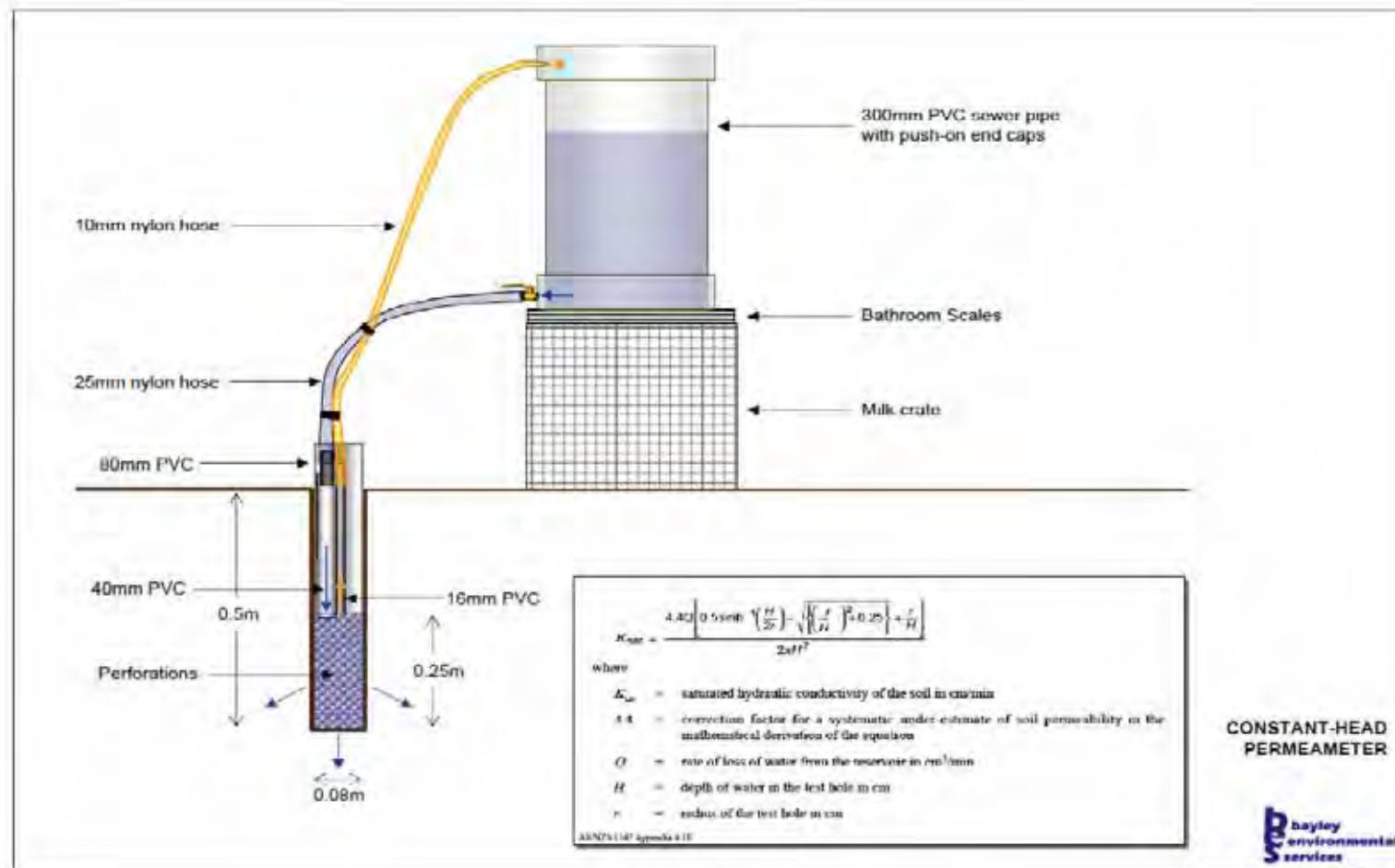
SOIL PERMEABILITY TEST

| | |
|----------|-----------|
| Site No. | K17 |
| Date | 5/11/14 |
| Easting | 407 337 |
| Northing | 6 446 456 |

| Time (h:m:s) | Weight (kg) | Change in Weight (kg) | Ks (m/d) |
|--------------|-------------|-----------------------|----------|
| 05:52:00 | 29.4 | | |
| 05:54:00 | 29.4 | | |
| 05:56:00 | 28.9 | 0.5 | 2.27 |
| 05:58:00 | 28.5 | 0.4 | 1.82 |
| 06:00:00 | 28.5 | | |
| 06:05:00 | 27.8 | 0.7 | 1.27 |
| 06:10:00 | 27.2 | 0.6 | 1.09 |
| 06:15:00 | 26.9 | 0.3 | 0.55 |
| 06:20:00 | 26.9 | | |
| 06:29:00 | 26.3 | | |
| 06:34:00 | 26 | 0.3 | 0.55 |
| 06:39:00 | 25.5 | 0.5 | 0.91 |
| | | 25.5 | |

H = 25
r = 4





Appendix C

Correspondence from DoW

From: [BRETNALL Richard](#)
To: [Phil Bayley \(bayley@inet.net.au\)](mailto:bayley@inet.net.au)
Cc: [CORPOLINA Mary Ann](#)
Subject: FW: Infiltration/detention basin in Canning River Floodway
Date: Thursday, 22 October 2015 11:54:47 AM
Attachments: [Infiltration_Detention_Basin.pdf](#)

Hi Phil

I refer to your email dated 22 October 2015.

The Department of Water uses the following guiding principles to ensure proposed development in floodprone areas is acceptable with regard to major flooding:

1. proposed development has adequate flood protection from a 100 year ARI flood
2. proposed development does not detrimentally impact on the existing 100 year ARI flooding regime of the general area

Based on the Canning River Flood Study, the proposed detention basin is located entirely within the floodway. The floodway is that part of the floodplain where proposed development that is considered obstructive to major flows is not acceptable as it would detrimentally impact on the existing flooding regime of the general area. The 100 year ARI flood level in the Canning River at this location is estimated to be ~20.00 m AHD.

For this proposal, the proposed detention basin will not adversely impact on major flooding and is therefore acceptable with regard to major flooding. However, it should be noted that some amount of damage would be expected to occur to the detention basin during major flooding.

Regards

Rick Bretnall
6364 6922

From: Phil Bayley [<mailto:bayley@inet.net.au>]
Sent: Thursday, 22 October 2015 11:24 AM
To: BRETNALL Richard
Subject: Infiltration/detention basin in Canning River Floodway

Hi Rick,

As we discussed, the attached shows the detention/compensating basin we plan to put (eventually) in the Canning River floodway in Kelmscott. This is part of a new structure plan for the Clifton St precinct, which currently has lot titles to the river. The new plan pulls the development

boundary back to outside the floodway, which will become regional and public open space.

The basin shown here is a combined 1-year infiltration basin and 100-year detention basin and will be constructed in public open space partly on the site of an existing pond. The existing pond is permanently full of water and will be partly backfilled to natural ground level.

The new basin will be excavated below the existing ground level at about 19.5m AHD, with no banks, bunds or other structures above the existing level. The existing shed/studio next to the pond and other structures in the floodway will be removed.

This plan is almost identical to the one we discussed in January this year, with the difference being that the new basin will be located about 10m further from the river than previously planned so as to provide enough height above the river to accommodate a combined infiltration and detention basin.

Can you please confirm that the basin as shown and described is acceptable to the DoW in terms of its compatibility with the protection of the floodway? Please don't hesitate to call if you need more information.

Thanks and regards,

Phil

Phil Bayley

BAYLEY ENVIRONMENTAL SERVICES

30 Thomas Street

SOUTH FREMANTLE 6162

tel: 08 9335 9160

fax: 08 9335 9160

mob: 0427 808 633

www.bayleyenvironmental.com.au

Disclaimer:

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Appendix D

Preliminary Drainage Calculations

RAN GARDENS

| SUBSTION (mm) | Flow |
|---------------|------|
| 5 | 84.3 |
| 6 | 80.2 |
| 10 | 48.1 |
| 20 | 23.8 |
| 32 | 26.7 |
| 50 | 17.6 |
| 120 | 11.5 |
| 180 | 8.86 |
| 360 | 5.86 |
| 720 | 3.83 |
| 1440 | 2.46 |
| 2880 | 1.58 |
| 4320 | 1.16 |

| Rainfall Intensity (mm/h) | | 1 Yr. 1 Hr Storm | |
|--|-------|------------------|--|
| Rainfall Intensity (mm/h) | 17.8 | 1 Yr. 1 Hr Storm | |
| Rainfall Excess Coefficient C ₁ | 0.64 | | |
| Rainfall Coefficient C ₂ | 0.08 | | |
| Rainfall Excess Coefficient C ₃ | 0.08 | | |
| Permeability K (m/hr) | 0.250 | | |
| Rainwater W ₁ (m) | 3.00 | | |
| Rainwater Storage Depth (m) | 0.21 | | |

| Road Area | Road/Verge Area A (m ²) | R ₁ | Lot Area (m ²) | R ₂ | RSD Area | R ₃ | R ₄ | Q (L/s) | V _{max} (m ³) | Rain Basin Area (m ²) | V ₁₀ (m ³) | Storage required | Depth in basin (m) | V _{max} (m ³) | Area Paved (m ²) | 25% Area | 1 year inundated area (m ²) |
|-----------|-------------------------------------|----------------|----------------------------|----------------|----------|----------------|----------------|---------|------------------------------------|-----------------------------------|-----------------------------------|------------------|--------------------|------------------------------------|------------------------------|----------|---|
| 1 | 7720.00 | 0.772 | 14830.00 | 1.483 | 2966.000 | 0.296 | 6380.40 | 31.07 | 111.98 | 288.00 | 52.73 | 38.11 | 0.23 | 35.24 | 288.00 | 194.40 | 320.78 |
| 2 | 2670.00 | 0.267 | 8370.00 | 0.837 | 838.000 | 0.084 | 3707.36 | 14.83 | 50.39 | 120.00 | 25.80 | 18.39 | 0.26 | 38.83 | 120.00 | 71.80 | 181.80 |
| 3 | 3430.00 | 0.343 | 7090.00 | 0.71 | 0.000 | 0.000 | 2762.40 | 13.52 | 48.98 | 80.00 | 16.67 | 31.99 | 0.40 | 32.00 | 80.00 | 64.00 | 155.40 |

DEFENTION BASINS

| | 1 yr | | | | | | | | | | | 100 yr | | | | | | | | Total Area (m ²) |
|-------------|--------------------------|-----------------------------------|---------------------------------|---|--|-------------|---------------|----------------|--------------------|----------------------------------|---------------------------------|---|---|-----------------|---------------|----------------|------------------------|----------------------------------|---------------------------------|------------------------------|
| | basin base perimeter (m) | basin base area (m ²) | Approx Volume (m ³) | Pre Development Outflow (m ³ /s) | Post Development Outflow (m ³ /s) | Basin Depth | Basin base RL | Basin Water RL | Basin Water Height | inundated Area (m ²) | approx Volume (m ³) | Predevelopment flow (m ³ /s) | Post Development flow (m ³ /s) | Basin Depth (m) | Basin base RL | Basin Water RL | Basin Water Height (m) | inundated Area (m ²) | Approx Volume (m ³) | |
| Catchment 1 | 84.362 | 258 | 495.8 | 0.092 | 0.082 | 1.2 | 29.5 | 29.8 | 0.3 | 552.07 | 540.8 | 0.264 | 0.330 | 1.200 | 21.300 | 29.83 | 1.2 | 810.0 | 487.3 | 640 |
| Catchment 2 | 61.877 | 210 | 328.2 | 0.049 | 0.045 | 1.2 | 18.3 | 19.163 | 0.863 | 187.9 | 198.8 | 0.193 | 0.192 | 1.200 | 18.300 | 19.413 | 1.115 | 490.8 | 368.4 | 510.33 |
| Catchment 3 | 59.53 | 80 | 287.8 | 0.045 | 0.045 | 1.2 | 20.0 | 20.76 | 0.76 | 244.3 | 216.7 | 0.179 | 0.153 | 1.200 | 20.000 | 21.068 | 1.03 | 317.1 | 161.0 | 279 |

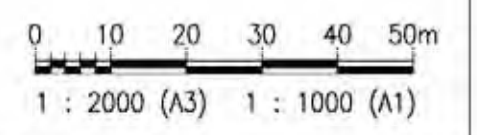
| | C ₁ | C ₂ | C ₃ | C ₄ |
|--|----------------|----------------|----------------|----------------|
| unobstructed flat | 0.56 | 0.67 | 0.70 | 0.84 |
| lowly sloped and road reserves | 0.64 | 0.76 | 0.80 | 0.95 |
| lowly sloping urban mixed use (commercial/ residential/ school/ church & shopping) | 0.72 | 0.88 | 0.90 | 1.00 |
| POS Areas | 0.72 | 0.86 | 0.90 | 1.00 |
| POS (streaming areas) | 0.08 | 0.10 | 0.10 | 0.12 |

Appendix E

Event Plans and Long Sections



LEGEND
 - - - - - CATCHMENT BOUNDARIES
 --- TOPOGRAPHY CONTOURS



| REV | DATE | DESCRIPTION | APPROVED |
|-----|----------|---|----------|
| D | 21.10.15 | DRAINAGE AMENDMENTS | JB |
| C | 08.10.15 | AMENDED TO INCORPORATE COUNCIL COMMENTS | JB |
| B | 09.01.15 | ISSUED FOR LSP SUBMISSION | JB |
| A | 23.12.14 | ISSUED FOR CLIENT REVIEW | JB |

CLIENT

Harley Dykstra
 PLANNING & SURVEY SOLUTIONS

LOCAL GOVERNMENT AUTHORITY

CITY OF Armadale

SCALE @A1
 HORIZ: 1:1000
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DATUM
 HORIZONTAL:
 VERTICAL:

SHAWMAC
 CONSULTING CIVIL AND TRAFFIC ENGINEERS

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| | |
|-------------|----------|
| DATE DRAWN: | 18.12.14 |
| DESIGNED: | JB |
| DRAWN: | NM |
| CHECKED: | JB |
| APPROVED: | T Shaw |

KELMSCOTT
 CLIFFTON STREET SOUTH LSP
 PRE-DEVELOPMENT CATCHMENT PLAN

DRAWING NUMBER:
 1410010-201

REV.
 D


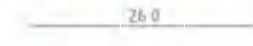
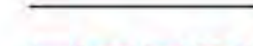






CATCHMENT 1
26,466m²

CATCHMENT 2
17,893m²

BASIN 2
AREA: 491m²
VOLUME: 328m³
TOP LEVEL: 19.5
BASE LEVEL: 18.3

LEGEND

-  CATCHMENT BOUNDARIES
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  CATCHMENT 1
-  CATCHMENT 2
-  CATCHMENT 3
-  PROPOSED BASIN LOCATION


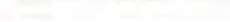





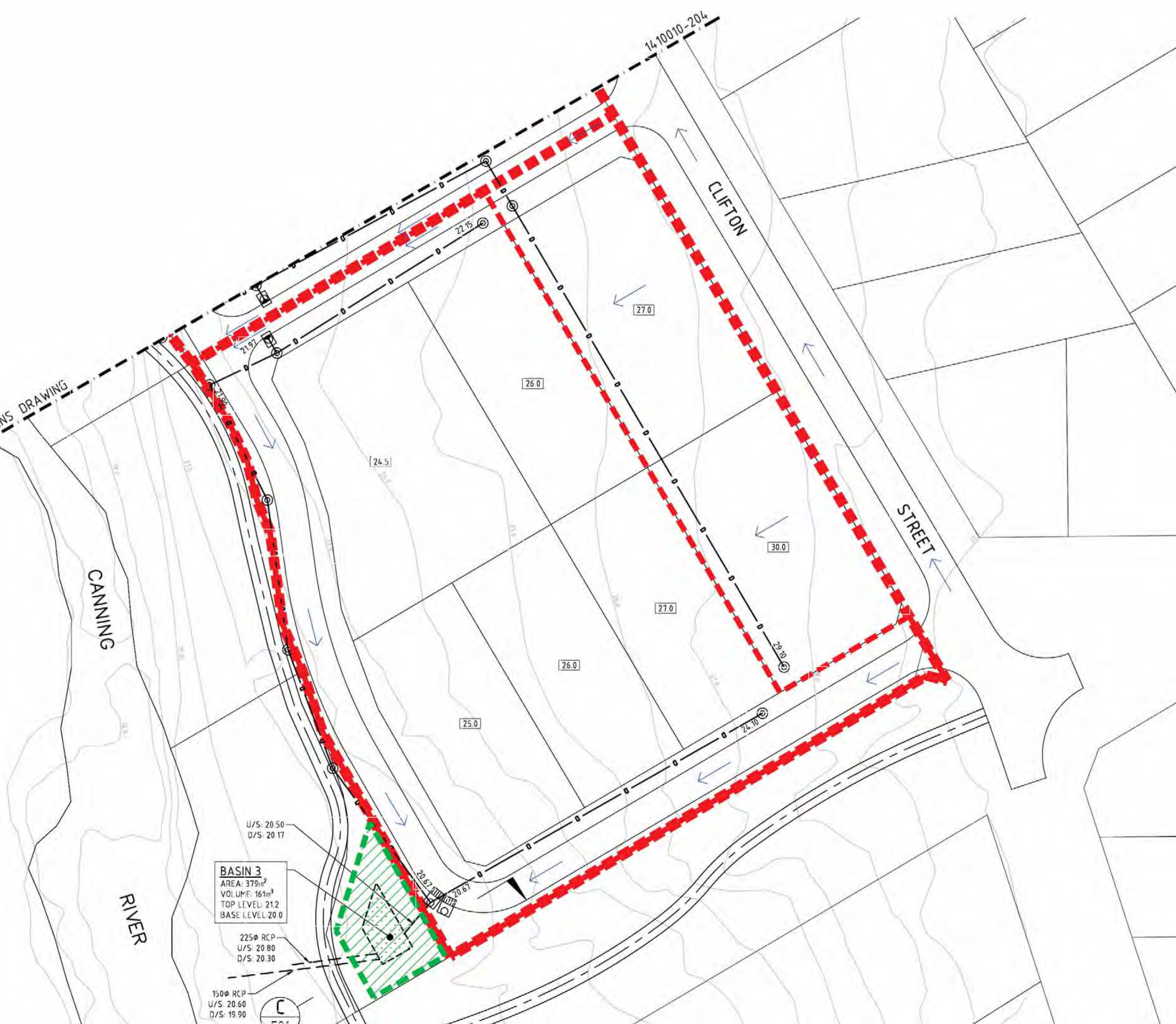
LEGEND

- - - CATCHMENT BOUNDARIES
- - - BASIN BOUNDARIES
- TOPOGRAPHY CONTOURS
- INDICATIVE SHARED PATH LOCATION
- 21.67 PROPOSED INVERT / OBVERT LEVEL
- |— PROPOSED DRAINAGE PIPE (375Ø RCP U.N.D.)
- - - PROPOSED BASIN OUTLET PIPE
- OVERLAND FLOW PATH
- PROPOSED COMBINATION PIT LOCATION
- PROPOSED GULLY PIT LOCATION
- PROPOSED MANHOLE LOCATION
- PROPOSED SIDE ENTRY PIT



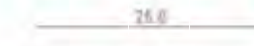

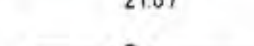


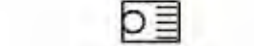
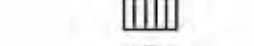
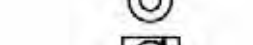


LEGEND

-  CATCHMENT BOUNDARIES
-  BASIN BOUNDARIES
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  PROPOSED INVERT / OBVERT LEVEL
-  PROPOSED DRAINAGE PIPE (375mm RCP U&D)
-  PROPOSED BASIN OUTLET PIPE
-  OVERLAND FLOW PATH
-  PROPOSED COMBINATION PIT LOCATION
-  PROPOSED GULLY PIT LOCATION
-  PROPOSED MANHOLE LOCATION



LEGEND

-  CATCHMENT BOUNDARIES
-  BASIN BOUNDARIES
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  PROPOSED INVERT / OBVERT LEVEL
-  PROPOSED DRAINAGE PIPE (375 ϕ RCP U.N.O.)
-  PROPOSED BASIN OUTLET PIPE
-  OVERLAND FLOW PATH
-  PROPOSED COMBINATION PIT LOCATION
-  PROPOSED GULLY PIT LOCATION
- PROPOSED MANHOLE LOCATION



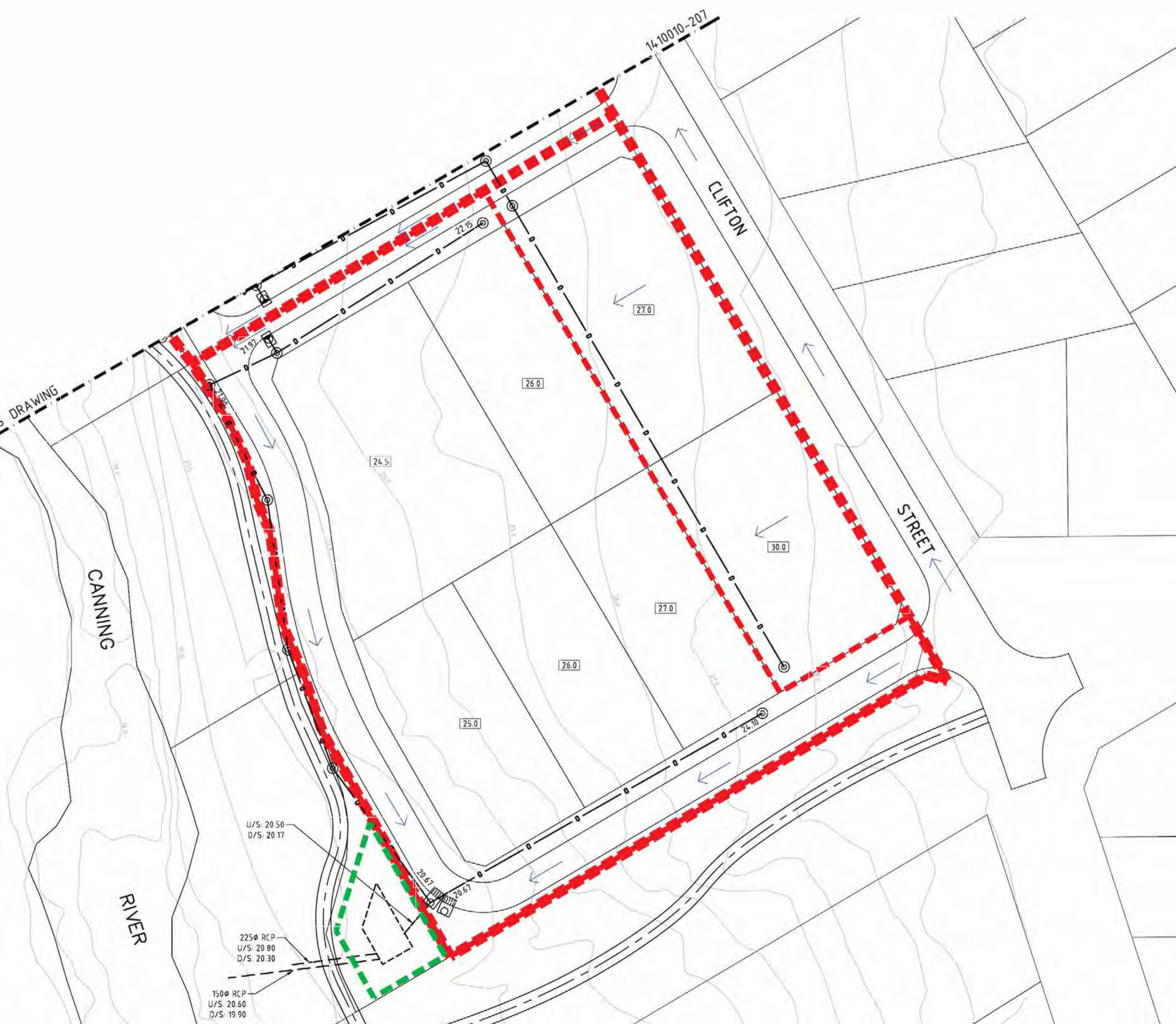
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- CATCHMENT BOUNDARIES
- BASIN BOUNDARIES
- INUNDATED AREAS
- TOPOGRAPHY CONTOURS
- INDICATIVE SHARED PATH LOCATION
- 21.67 PROPOSED INVERT / OBVERT LEVEL
- PROPOSED DRAINAGE PIPE (375 ϕ REP U.N.D.)
- PROPOSED BASIN OUTLET PIPE
- OVERLAND FLOW PATH
- + PROPOSED COMBINATION PIT LOCATION
- PROPOSED GULLY PIT LOCATION




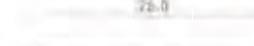
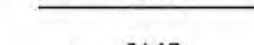
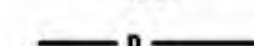


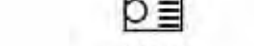



LEGEND

- CATCHMENT BOUNDARIES
- BASIN BOUNDARIES
- INUNDATED AREAS
- TOPOGRAPHY CONTOURS
- INDICATIVE SHARED PATH LOCATION
- 21.67 PROPOSED INVERT / OBVERT LEVEL
- PROPOSED DRAINAGE PIPE (375φ REP U.N.O.)
- PROPOSED BASIN OUTLET PIPE
- OVERLAND FLOW PATH
- PROPOSED COMBINATION PIT LOCATION
- PROPOSED GULLY PIT LOCATION
- PROPOSED MANHOLE LOCATION








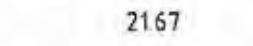





LEGEND

-  CATCHMENT BOUNDARIES
-  BASIN BOUNDARIES
-  INUNDATED AREAS
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  PROPOSED INVERT / OBVERT LEVEL
-  PROPOSED DRAINAGE PIPE (375mm RCP U.N.D.)
-  PROPOSED BASIN OUTLET PIPE
-  OVERLAND FLOW PATH
-  PROPOSED COMBINATION PIT LOCATION
- PROPOSED GULLY PIT LOCATION



5 YEAR STORAGE
 SURFACE AREA: 532m²
 VOLUME: 341m³
 WATER LEVEL: RL. 20.4

LEGEND

-  CATCHMENT BOUNDARIES
-  BASIN BOUNDARIES
-  INUNDATED AREAS
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  PROPOSED INVERT / OBVERT LEVEL
-  PROPOSED DRAINAGE PIPE (375Ø RCP UNO)
-  PROPOSED BASIN OUTLET PIPE
-  OVERLAND FLOW PATH
-  PROPOSED COMBINATION PIT LOCATION
-  PROPOSED GULLY PIT LOCATION



LEGEND

- CATCHMENT BOUNDARIES
- BASIN BOUNDARIES
- INUNDATED AREAS
- TOPOGRAPHY CONTOURS
- INDICATIVE SHARED PATH LOCATION
- 21.67 PROPOSED INVERT / OBVERT LEVEL
- PROPOSED DRAINAGE PIPE (375φ RCP U.N.D.)
- PROPOSED BASIN OUTLET PIPE
- OVERLAND FLOW PATH
- PROPOSED COMBINATION PIT LOCATION
- PROPOSED GULLY PIT LOCATION





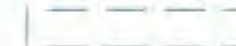

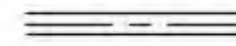
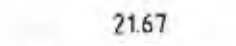
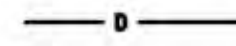
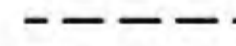

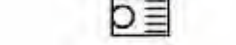

LEGEND

| | |
|--|--|
| | CATCHMENT BOUNDARIES |
| | BASIN BOUNDARIES |
| | INUNDATED AREAS |
| | TOPOGRAPHY CONTOURS |
| | INDICATIVE SHARED PATH LOCATION |
| | PROPOSED INVERT / OBVERT LEVEL |
| | PROPOSED DRAINAGE PIPE (375 RCP U N D) |
| | PROPOSED BASIN OUTLET PIPE |
| | OVERLAND FLOW PATH |
| | PROPOSED COMBINATION PIT LOCATION |
| | PROPOSED GULLY PIT LOCATION |



100 YEAR STORAGE
 SURFACE AREA: 670m²
 VOLUME: 454m³
 WATER LEVEL: R.L. 20.6

LEGEND

-  CATCHMENT BOUNDARIES
-  BASIN BOUNDARIES
-  INUNDATED AREAS
-  TOPOGRAPHY CONTOURS
-  INDICATIVE SHARED PATH LOCATION
-  PROPOSED INVERT / OVERT LEVEL
-  PROPOSED DRAINAGE PIPE (375Ø RCP U.N.O.)
-  PROPOSED BASIN OUTLET PIPE
-  OVERLAND FLOW PATH
-  PROPOSED COMBINATION PIT LOCATION
-  PROPOSED GULLY PIT LOCATION

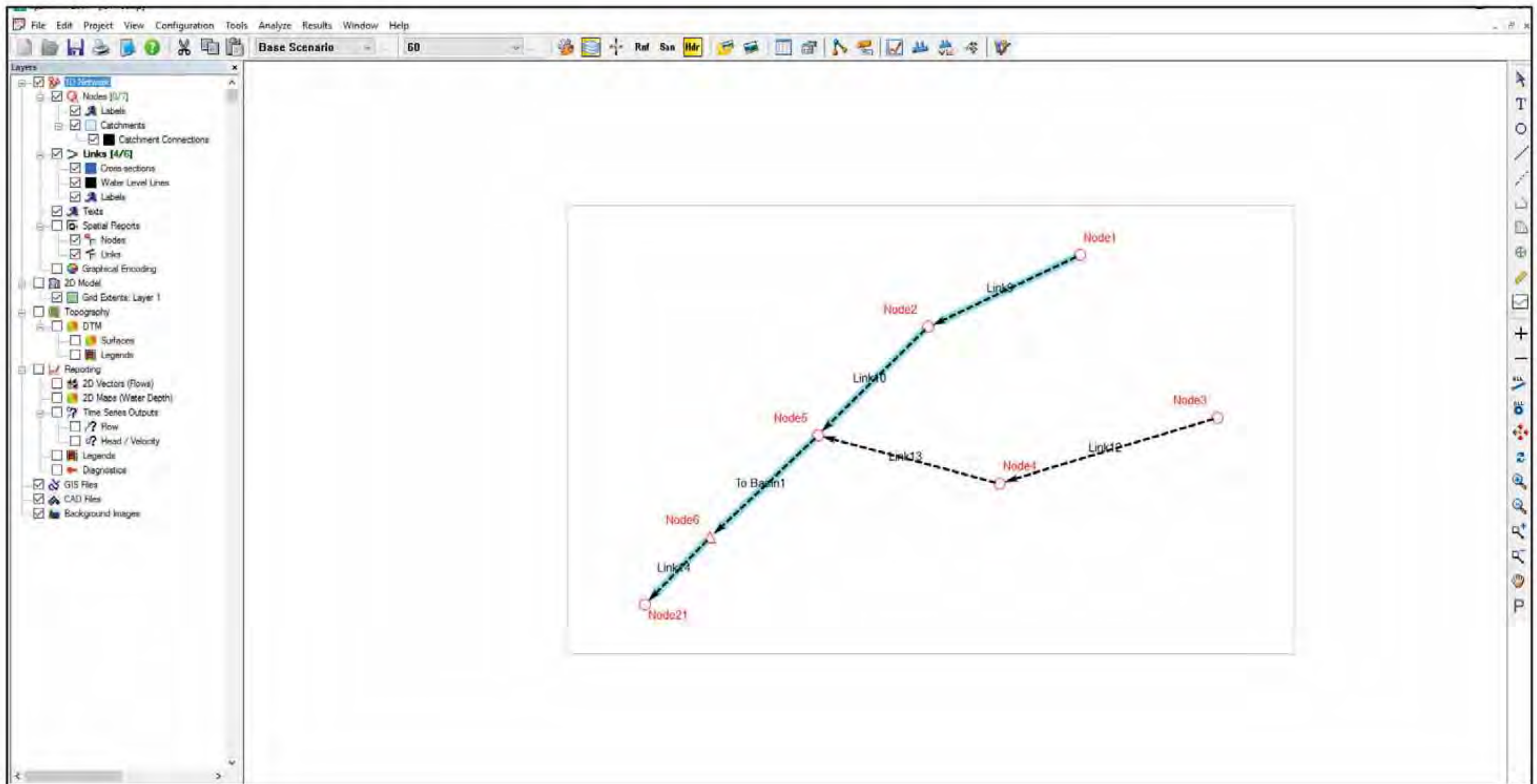




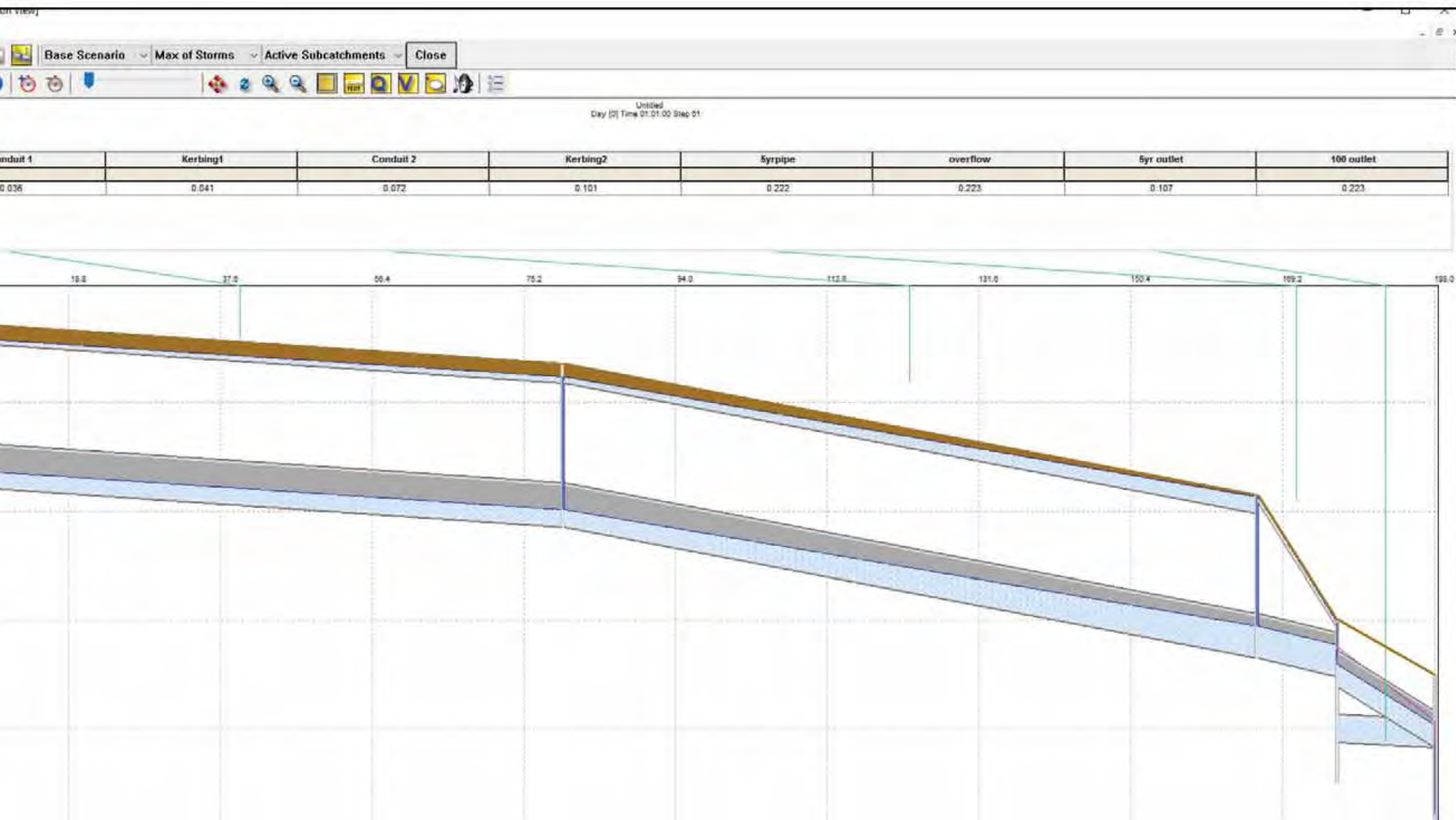
LEGEND

- CATCHMENT BOUNDARIES
- BASIN BOUNDARIES
- INUNDATED AREAS
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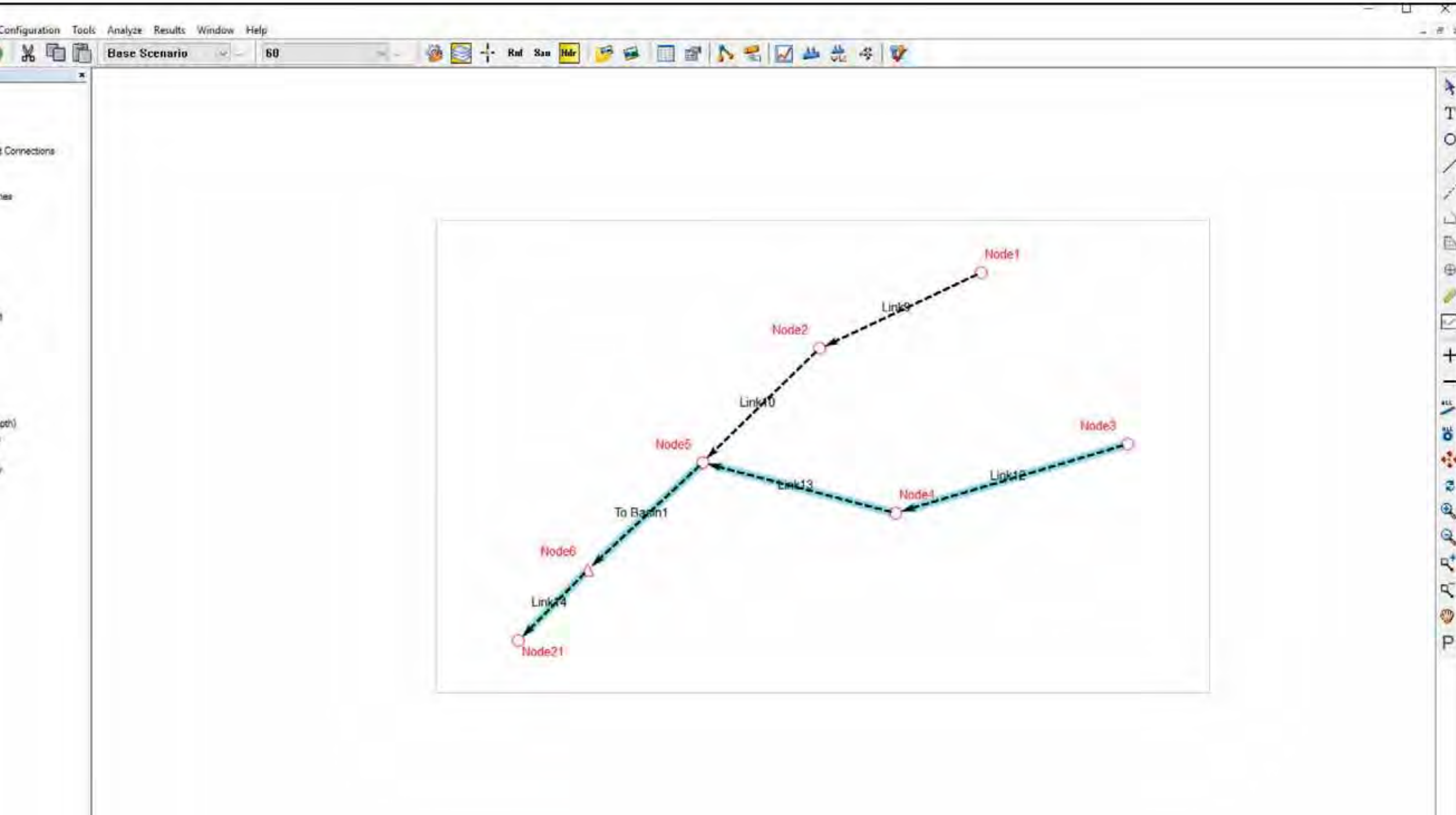
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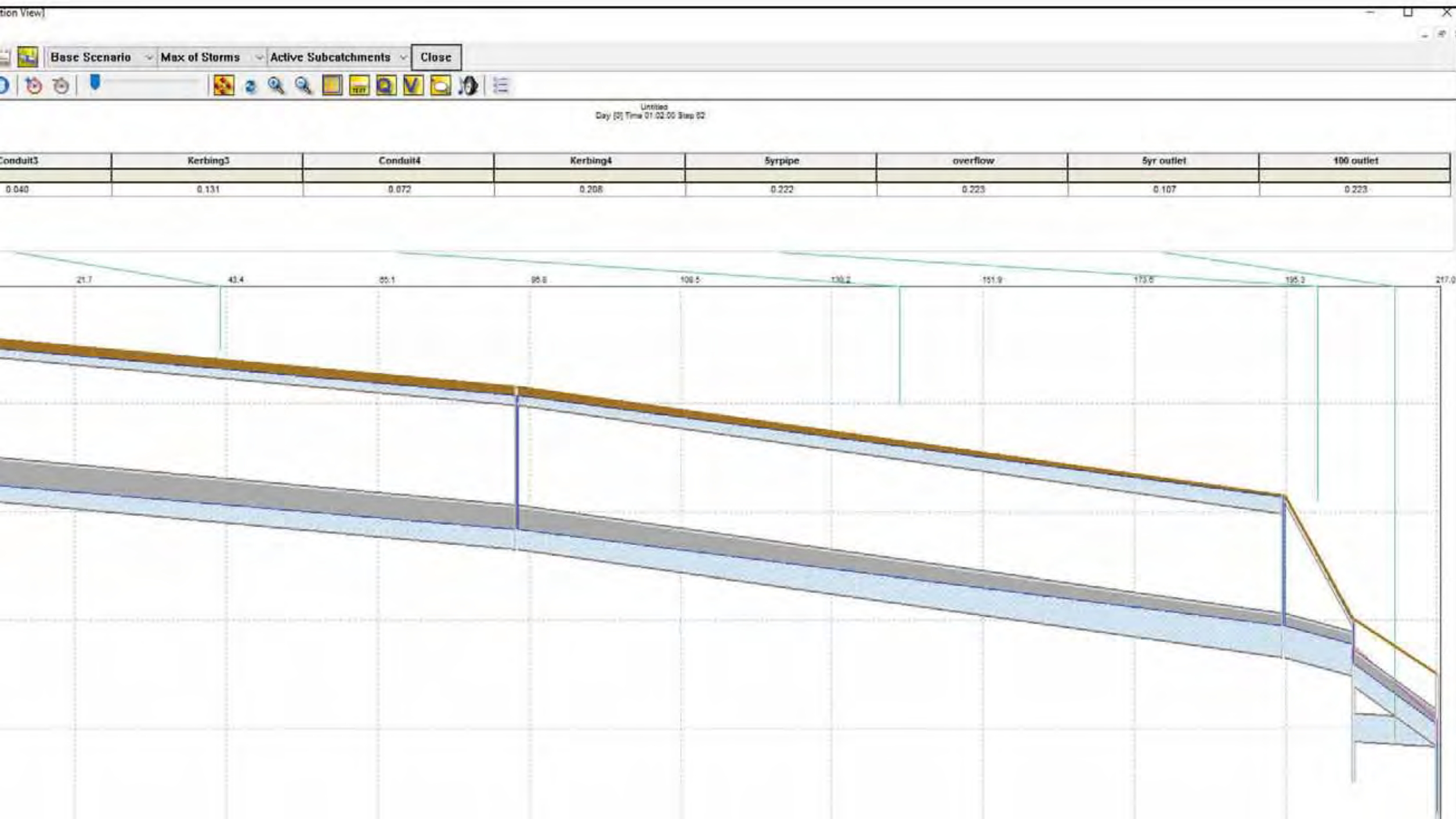
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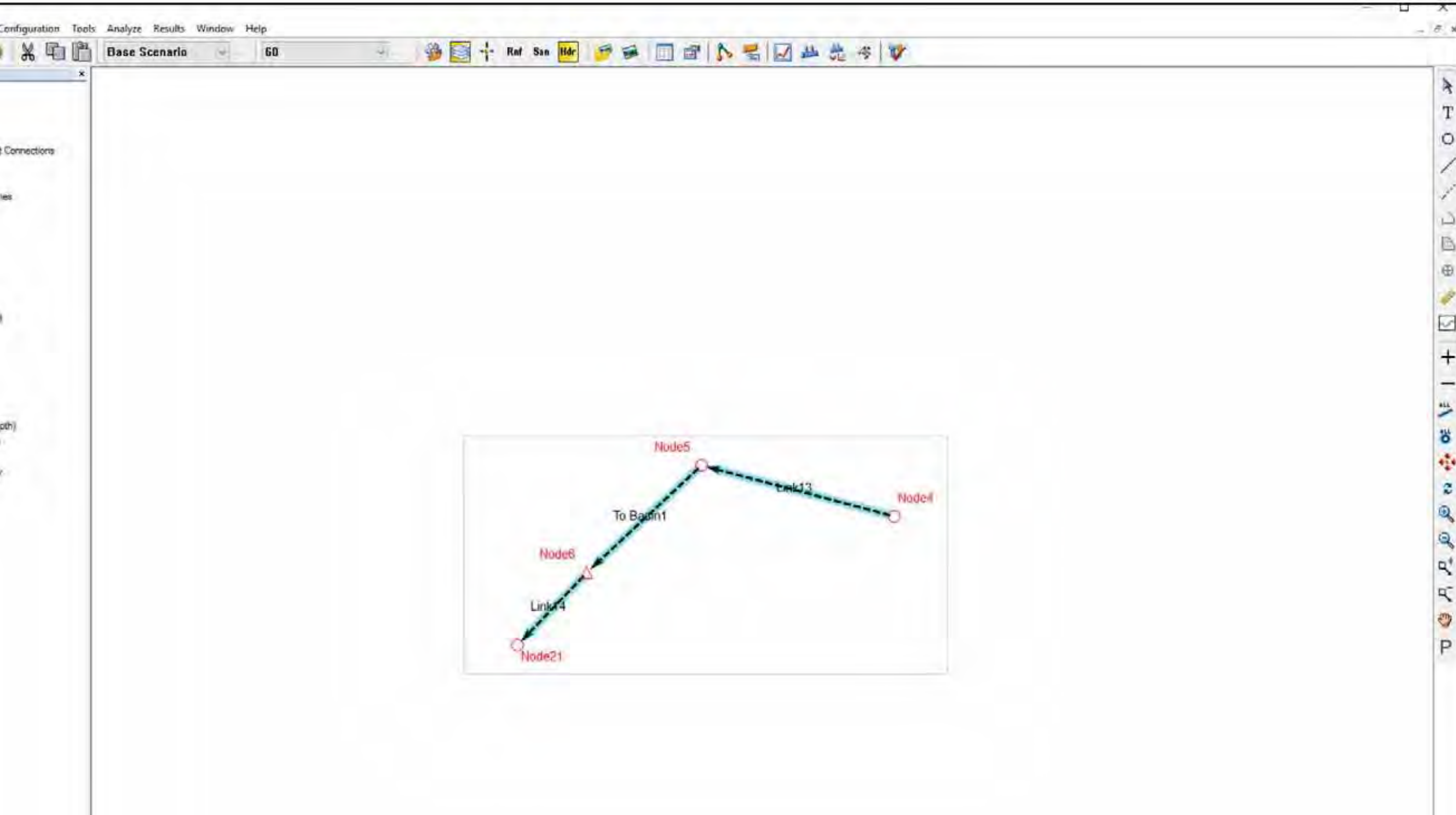
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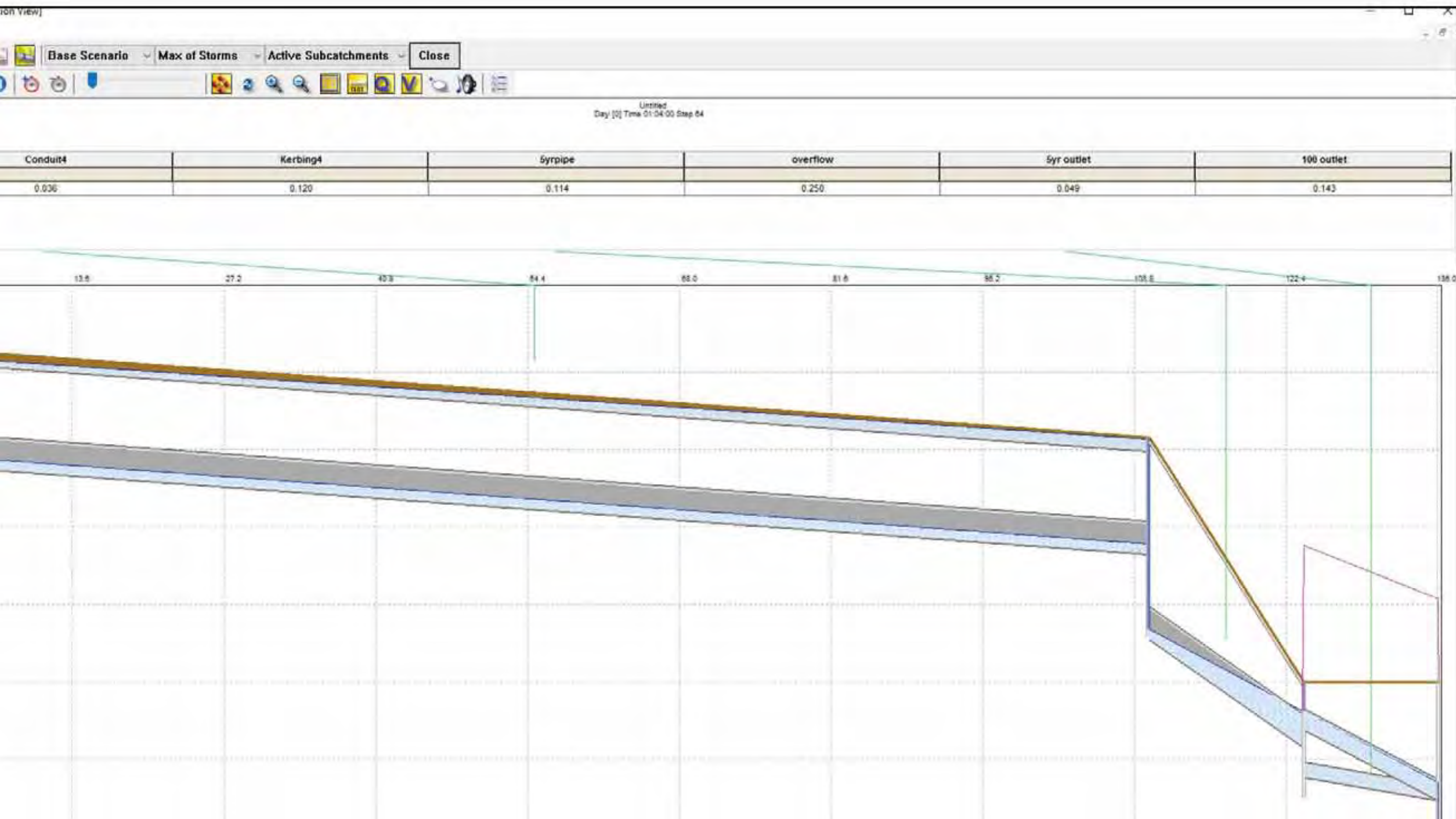
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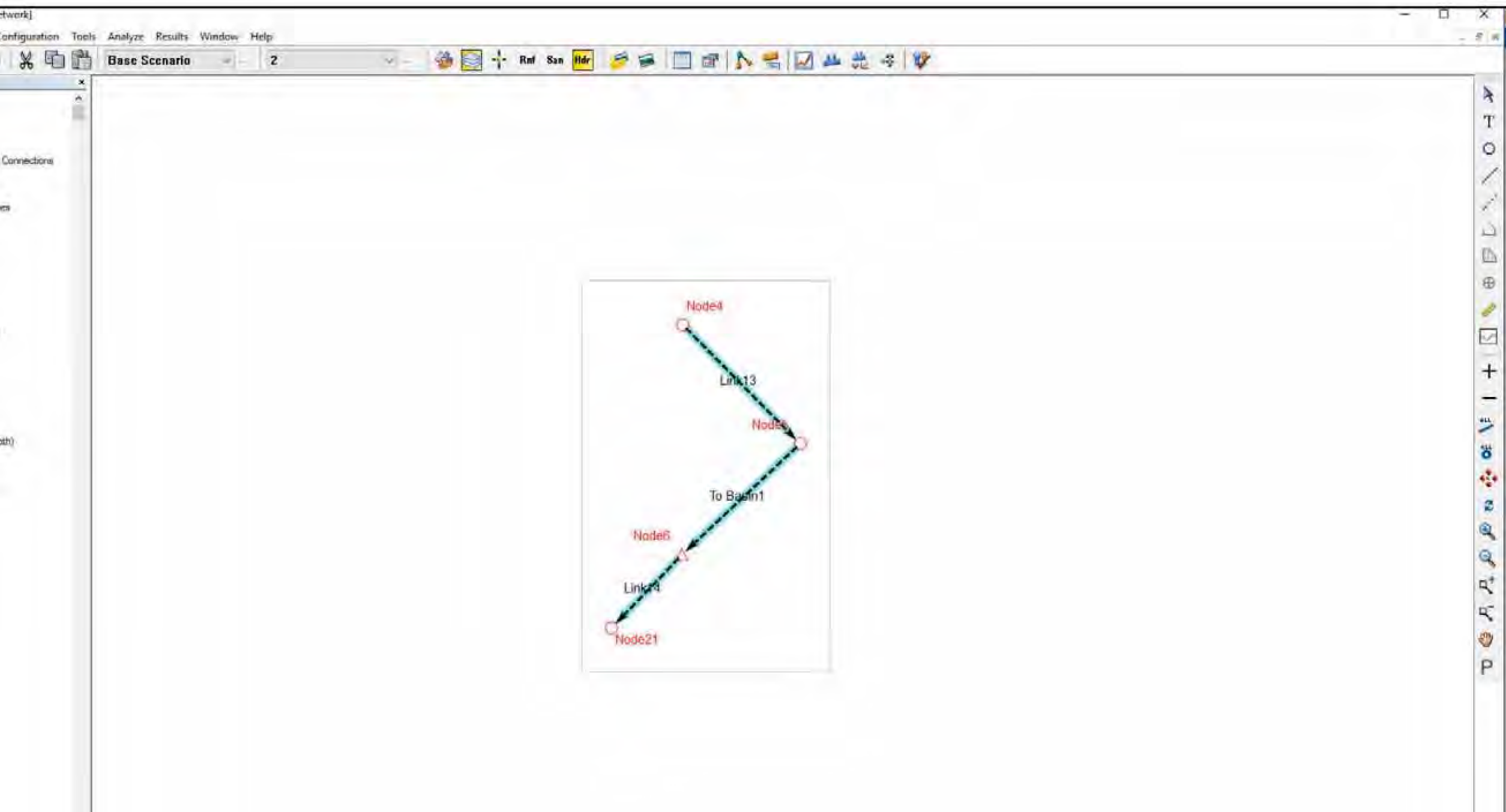
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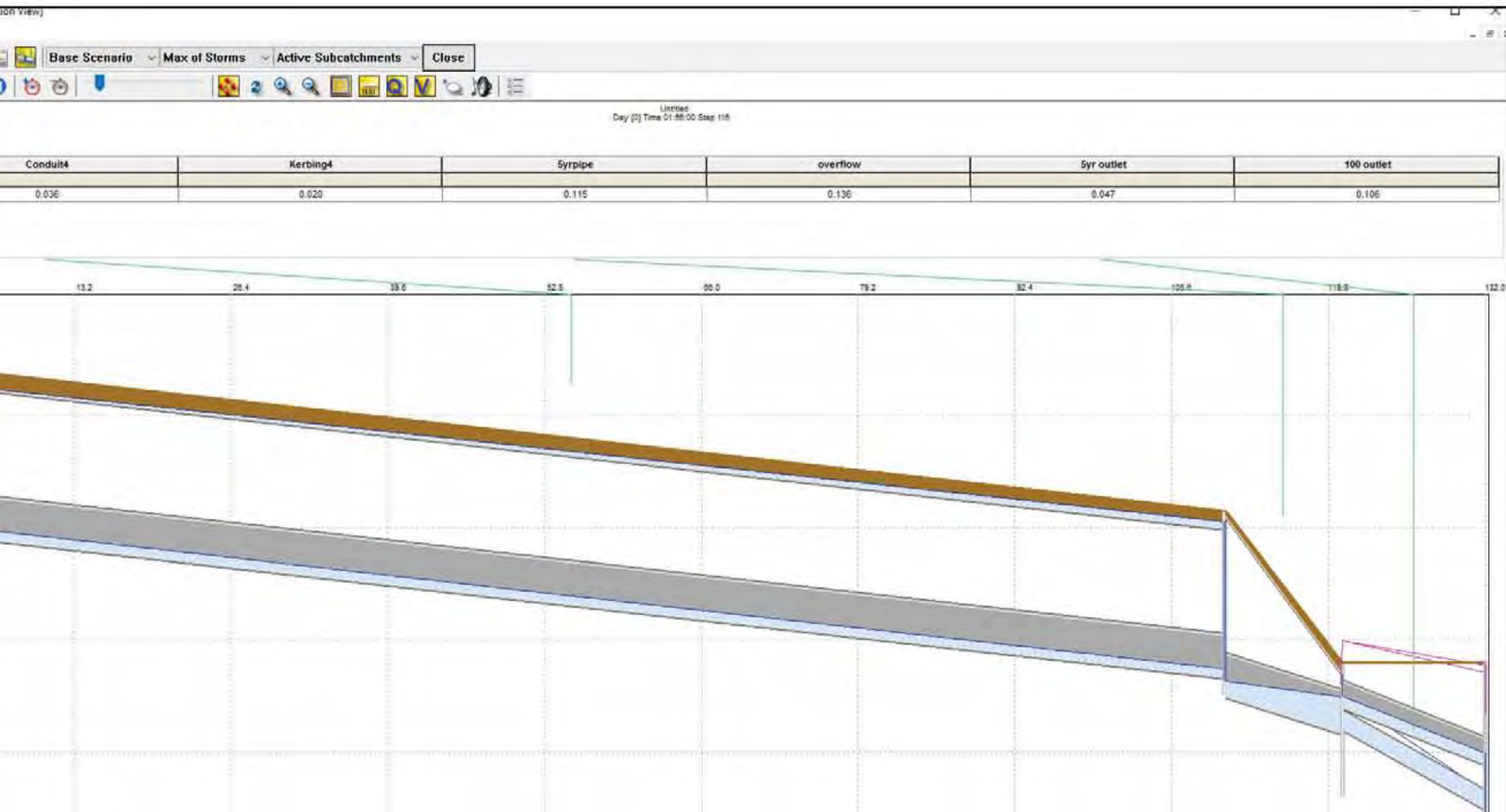
Line 1 Alignment



Line 1 Alignment



Line 1 Output



APPENDIX D

Traffic Impact Assessment & Technical Note Shawmac

Minor modifications to the LSP layout were required by the WAPC which are inconsequential to the assessment of traffic matters contained in the Traffic Impact Assessment & subsequent Technical Note.



CONSULTING CIVIL & TRAFFIC ENGINEERS, RISK MANAGERS.



Civil Engineering



Traffic Engineering




Risk Management

Project: Transport Impact Assessment – V3
Clifton Street South LSP

Client: Harley Dykstra

Job Number: 1410010

Author: Angela Wetton

Signature: 

Date: 7th October 2015

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Document Status

| Version No. | Author | Reviewed by | Date | Document status | Signature | Date |
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| 1 | H. Lansdell | T. Shaw | 15/12/14 | FINAL |  | 17/12/14 |
| 2 | H. Lansdell | T. Shaw | 15/01/15 | FINAL |  | 16/01/15 |
| 3 | H. Lansdell | T. Shaw | 19/01/15 | FINAL |  | 19/01/15 |
| 4 | A Wetton | B Hartley | 7/10/15 | FINAL |  | 7/10/15 |
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1. INTRODUCTION

Shawmac has prepared a Transport Impact Assessment for the proposed Clifton Street South Local Structure Plan area to be located on the west side of Clifton Street, broadly between Gilwell Avenue and Martin Street, Kelmscott, in the City of Armadale. The subject land is located due east of the existing Kelmscott Town Centre and the Kelmscott Railway Station.

Proposed access points to the primary boundary road system to serve the Local Structure Plan consist of four (4) east-west local road connections, with a possible fifth connection, to the west side of Clifton Street, between Gilwell Avenue and Martin Street.

The internal road network is to consist of a series of local access roads which connect to the existing boundary road network in a permeable grid fashion to allow for maximal efficient distribution of locally-generated traffic.

This assessment has been prepared in a format suitable for submission to the City of Armadale as well as the Department of Transport, Main Roads Western Australia, the Public Transport Authority and the Western Australian Planning Commission. This assessment has been prepared in accordance with the WAPC *Guidelines for Transport Assessment – Volume 2: Structure Plans* and the *City of Armadale Town Planning Scheme No. 4* and other relevant district planning policies.

2. EXISTING AND PLANNED FUTURE TRANSPORT NETWORK

The subject land is located on the west side of Clifton Street, broadly between Gilwell Avenue and Martin Street, Kelmscott in the City of Armadale. The subject land is bounded by Clifton Street to the east, the Canning River to the west, existing residential uses and Gilwell Avenue to the north and existing residential uses to the south. The subject land is located within the Kelmscott Town Centre and within walking distance to the Kelmscott Railway Station. The subject land is currently mainly vacant with several single family dwellings located fronting onto Clifton Street.

The broader metropolitan context of the LSP area is shown in Figure 1.



Figure 1: Metropolitan Context of Local Structure Plan Area

Figure 2 below outlines the location of the Local Structure Plan Area.

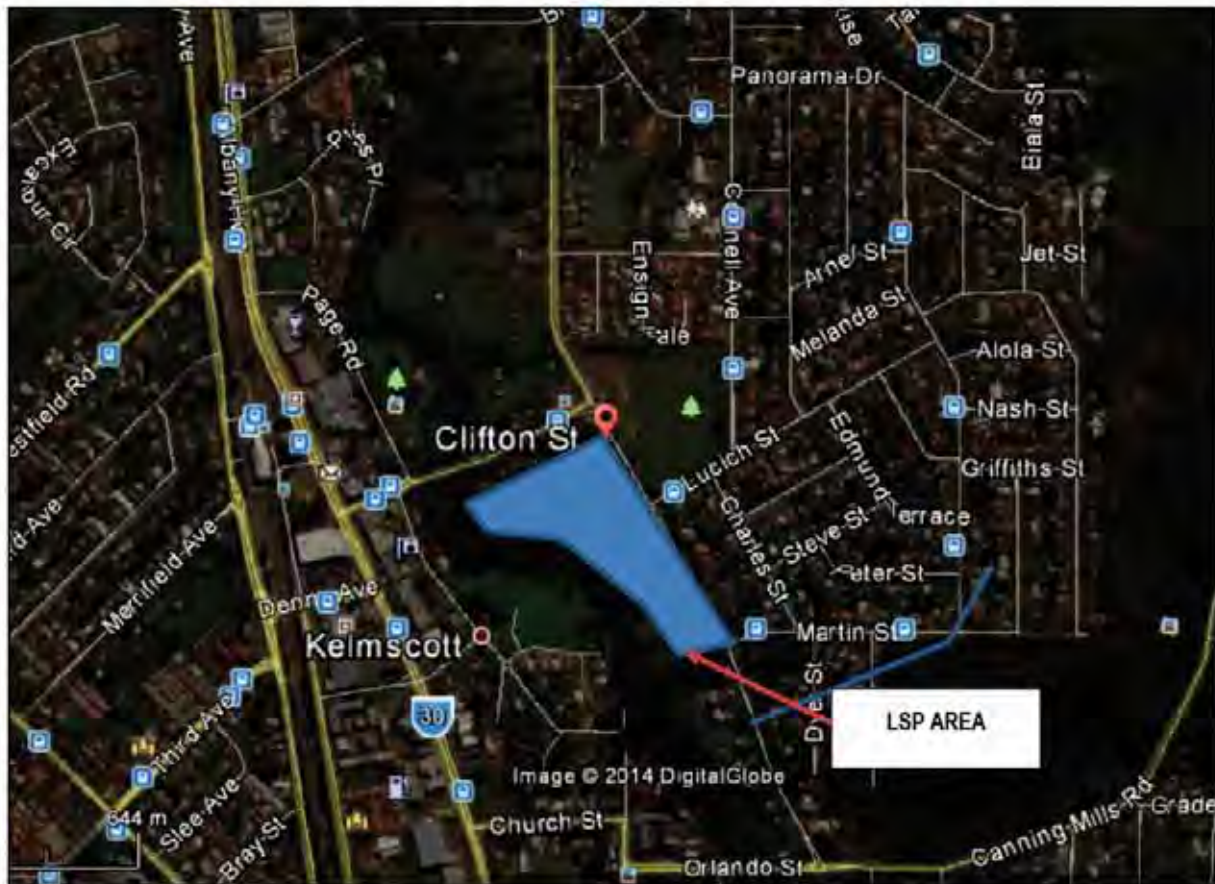


Figure 2: Local Context of Local Structure Plan Area

2.1. Road Network

Albany Highway

Albany Highway is a north-south major road which connects the Perth CBD with the south-eastern suburbs of the Perth Metropolitan Area through major regional and district centres such as Cannington, Kenwick, Kelmscott and Armadale. It has been classified as a *Primary Distributor* road under the Main Roads WA *Functional Road Hierarchy* which is defined as a road which "...provides for major regional and inter-regional traffic movement and carry large volumes of generally fast moving traffic. It is a strategic freight route, a State Road and is maintained by Main Roads Western Australia." Albany Highway, to the west of the lands has been constructed as a dual divided carriageway, and operates under a speed limit of 60kph. It is owned, operated and maintained by Main Roads Western Australia.

Gilwell Avenue

Gilwell Avenue is broadly an east-west aligned road which runs between Albany Highway and Clifton Street. It has been classified as a *Local Distributor* road which is defined as a road which "...plays a role in providing direct road connections between District Distributor roads and Local roads and facilitates movement of traffic within local areas and connects Access Roads to higher order Distributor Roads." In the vicinity of the subject lands, it has been



constructed as a wide single undivided carriageway terminating at its western end at Albany Highway with the Gilwell Avenue approach operating under Stop Control. It operates under a speed limit of 50kph and is owned, operated and maintained by the City of Armadale.

Clifton Street

Clifton Street is broadly a north-south aligned road which runs between Gilwell Avenue and Orlando Street along the eastern boundary of the subject lands. It has also been classified as a *Local Distributor* road. In the vicinity of the subject lands, it has been constructed as a single divided carriageway with a 1.5m flush median between Gilwell Avenue and Lucich Street with the road transitioning further south to a single undivided carriageway. It operates under a speed limit of 50kph and is owned, operated and maintained by the City of Armadale. The Clifton Street/Gilwell Avenue intersection is controlled by a single circulating roundabout.

Lucich Street

Lucich Street is broadly an east-west aligned road which runs between Clifton Street and Merilee Terrace opposite the eastern eastern boundary of the subject lands. It has also been classified as a *Local Distributor* road. In the vicinity of the subject lands, it has been constructed as a single undivided carriageway. It operates under a speed limit of 50kph and is owned, operated and maintained by the City of Armadale.

Martin Street

Martin Street is an east-west aligned road located opposite the southern boundary of the lands intersecting with Clifton Street at a T-intersection. This road has been classified as an *Access Road* which is defined as a road which "...plays a role in connecting to Distributor roads and other Access roads as well as facilitating the movement of road traffic within local areas and connect the local road network to the higher order boundary road network." In the vicinity of the subject land, it has been constructed as a single undivided carriageway and operates under a speed limit of 50kph. It is owned, operated and maintained by the City of Armadale. Existing traffic volumes for the boundary road network are shown in Table 1.

Existing traffic volumes are shown in Table 1.

Table 1: Existing Daily Traffic Volumes (Source: MRWA)

| Road | Daily Traffic Volume (vpd) | Date |
|----------------|----------------------------|--|
| Albany Highway | 25,500 vpd | 2014 |
| Gilwell Avenue | 5,100 vpd | 2014 |
| Clifton Street | 4,600 vpd | 2011 |
| Lucich Street | <1,500vpd | Data not available; however, assumed based upon spatial distribution of land uses and existing travel patterns |
| Martin Street | <1,000 vpd | Data not available; however, assumed based upon spatial distribution of land uses and existing travel patterns |

2.2. Existing Public Transport Network

Existing public transport services to the general area are limited to the Transperth Bus Route 220 (Armadale-Perth via Albany Highway) which is a line haul service along Albany Highway. Bus stops are in place on both sides of Albany Highway within 450m walking distance to the site with service operating at 20-minute frequencies during the weekday a.m. and p.m. peak periods and hourly service during the midday, evening and weekend periods. Bus stops are also in place on both sides of Gilwell Avenue providing local bus connections. The Kelmscott Railway Station is located within 550m walking distance of the site with frequent service in place between Armadale Railway Station and Perth Central Railway Station providing 15- to 20-minute service during the weekday peak periods. Figure 3 illustrates the existing public transport services in the area.



Figure 3: Existing Public Transport Services

2.3. Existing Pedestrian and Cycling Network

The subject land is well served well by established existing pedestrian and cycling infrastructure which includes the following:

- A footpath on both sides of Albany Highway to the west of the site with the eastern footpath transitioning to a dual use path further south in the vicinity of Streich Avenue;
- A dual use path along the Armadale-Perth railway line;
- A dual use path on the west side of Clifton Street adjacent to the eastern boundary of the site;
- A footpath on the north side of Gilwell Avenue;
- A dual use path on the north side of Martin Street; and
- Both Gilwell Avenue and Lucich Street designated as *Bicycle Friendly Streets*.

Figure 4 illustrates the existing pedestrian and cycling network in the vicinity of the LSP lands.



Figure 4: Existing Pedestrian and Cycling Network



3. LOCAL STRUCTURE PLAN PROPOSAL

The proposed land uses within the Local Structure Plan area comprises R40, R60 and R80 medium and high density dwellings and Public Open Space (POS). The number of dwellings has been assumed based upon the average site areas per dwelling prescribed by the *State Planning Policy 3.1: Residential Design Codes* resulting in approximately 384 single family, grouped and multiple dwellings.

The LSP area is proposed to be served by four (4) broad east-west connections to the existing established boundary road network (Clifton Street) with the possible inclusion of a fifth road connection.

The internal road network is to consist of a series of *Access Roads* which connect to the existing boundary road network in a permeable grid fashion to allow for maximal efficient distribution of locally-generated traffic.

The LSP concept plan indicates an intention for new dwelling fronting Clifton Street to be provided with vehicle access via a rear laneway or from the adjacent proposed local access streets. Access requirements (i.e. egress from the sites in forward gear) can be specified at the detailed subdivision and development stages, should direct access to Clifton St be proposed.

The proposed Local Structure Plan is attached in **Appendix A**.

4. TRANSPORT IMPACT ASSESSMENT

In order to assess the potential traffic impacts associated with the proposed uses detailed in the Local Structure Plan on the boundary road network, a traffic generation and distribution exercise has been undertaken. The aim of this exercise was to establish the anticipated traffic volumes which would be generated from the proposed development of the Local Structure Plan in order to quantify the effect that the additional traffic has on the boundary road network, specifically on the operations of the adjacent boundary road network.

4.1. Trip Generation

Trip generation rates were applied using the Institute of Transportation Engineers (ITE) *Trip Generation Manual, 8th Edition*. The categories chosen for the assessment were *Single-Family Detached Housing (Category 210)* for the R40 dwelling and *Residential Condominium/Townhouse (Category 230)* for the grouped and multiple dwellings. The proposed directional distribution of trips was also derived from ITE rates.

Based upon the proposed land uses, it is estimated that the Local Structure Plan area will generate in the order of 2,344 (1,172 inbound/1,172 outbound) vpd on a typical weekday, with approximately 172 (24 inbound/153 outbound) vehicle trips and 214 (171 inbound/43 outbound) vehicle trips during both the a.m. and p.m. weekday peak hours, respectively.

A review of the 2031 future traffic volumes throughout the subject area indicates that development in the area has been included in these predicted future volumes with sufficient residual capacity available to accommodate the subject site's demands.

4.2. Trip Distribution and Assignment

The following assumptions have been made for the distribution of the site-generated traffic:

- 70% of site-generated traffic would enter and exit the subject lands via Clifton Street (north) via Gilwell Avenue towards Albany Highway; and
- 30% of site-generated trips enter and exit the subject lands via Clifton Street (south).

The proposed split of traffic has been based upon the spatial distribution of land uses in the area, existing traffic patterns and connection to the boundary road network with the primary desire lines to and from the north towards and from the Perth CBD and higher order road networks. The majority of the site-generated trips (70%) are likely to be made to and from locations external to the immediate area. The most practical route to the higher order road network is via Clifton Street towards the north which provides access to Albany Highway via Gilwell Avenue. The remaining proportion (estimated as 30%) account for travel to locations immediately to the south of the site or for drivers travelling further south via the back routes to avoid the higher road network.

Figure 5 illustrates the total anticipated daily traffic volumes on the existing boundary road network and future internal road network associated with the proposed development of the Local Structure Plan.

An additional east-west road is notionally identified on the LSP on the common boundary of Lots 24 and 25. A road in this location is not essential for traffic movement purposes, given the small scale of this southern development cell. A road is, however, identified in this location should Lots 24 and/or 25 be developed in advance of Lots 23 and 26 (which is considered to be a likely prospect). The provision of a road in this location will enable access to the foreshore to be provided independent of the development of Lot 23 and/or 26.

This possible road could be located equally on Lots 24 and 25 if developed together or partially or wholly on either if a single lot is developed prior to the other. Arrangements for the sharing of costs associated with the development of this road should be negotiated between the owners of these lots at the time of subdivision and development.

Should development of Lots 24 and 25 occur after the development of either of Lots 23 or 26, then this potential road is unlikely to be required. Similarly, if all of Lots 23 to 26 were to be developed simultaneously, then this road is not likely to be needed. Under these scenarios, a landowner or developer may still opt to construct an east-west road on or in the vicinity of the common boundary of Lot 24 and 25 for building design and access reasons.



Figure 5: Daily Future Traffic Volumes – LSP Area

4.3. Traffic Analysis

Austrroads' Guide to Traffic Management provides advice on the capacity of unsignalised intersections. For minor roads where there are relatively low volumes of turning traffic, capacity considerations are usually not significant and capacity analysis is unnecessary. Intersection volumes below which capacity analysis is unnecessary are indicated in Table 2.

Table 2: Threshold Analysis Parameters (Austrroads, 2009)

| Type of Road | Light cross and turning volumes maximum design hour volumes (vehicles per hour (two way)) | | |
|----------------------|--|-----|-----|
| Two -lane major road | 400 | 500 | 650 |
| Cross road | 250 | 200 | 100 |

Due to the low turning volumes expected to occur at the internal and nearby intersections, further intersection capacity analysis is not required.

The additional traffic generated by the LSP on a daily basis and the proposed permeable layout of the future development within the area with linkages to the north and east will allow for an efficient distribution of traffic with the additional traffic comfortably accommodated within the practical road network capacities of the existing road network.

5. STRUCTURE PLAN MOVEMENT NETWORKS

5.1. Intersection and Lane Treatments

All intersection internal to the Local Structure Plan Area will be basic priority-controlled T-intersections due to the relatively low traffic volumes. Local intersection connections with Clifton Street are proposed to typically operate under T-intersection Give Way control. The City's Technical Services have advised that two full movement intersections to Clifton Street will be permitted for the LSP area. The remainder of the intersections are required to be left-in/left-out only.

Details associated with the design of any required intersection treatments, including any new and upgraded local road connections to the primary road network will be identified and concept designs will be prepared during the detailed subdivision stages of the development, in consultation with the City of Armadale. The City may require future developers or subdividers to investigate the need for any modifications or upgrades to existing traffic management devices in the abutting Clifton Street reserve. If lot design or development form requires, such traffic management devices may need to be upgraded or modified. Such investigations/upgrades may include the existing intersection of Gilwell Avenue and Martin Street given its proximity to LSP area. It is noted that the former intersection has been the subject of recent upgrade works.

The local intersection connections with Clifton Street typically proposed to operate under T-intersection Give Way control. The proposed intersection with Clifton Street in the vicinity of both the existing Lucich Street and Martin Street intersections will be sufficiently offset as to satisfy *Austrroads Guide to Traffic Engineering Practice: Part 4A – Road Design* which recommends a minimum 8 to 15m offset stagger (in a left-right arrangement) which has been satisfied by the proposed road layout. The expected conflict between the inbound right-turning movements at these intersections is expected to be low due to the expected low volumes turning into and out of the local road connections during peak periods and a review of the crash history indicates a very low rate of side swipes or right-angle crashes along Clifton Street.

5.2. Pedestrian and Cyclist Facilities

Footpaths are proposed to be provided on at least one side of each of the internal local roads with connections to the established pedestrian and cycling network external to the area. It is recommended that all footpaths are constructed with a minimum width of 1.5 metres.

A new shared pedestrian and cyclist path is to be provided along the western boundary of the LSP area. This pathway will play an important role in connecting the LSP area with the Kelmscott District Centre and railway station, via the Gilwell Avenue Bridge. New east-west shared path connections are also identified at the northern end of the LSP and within the future Martin St local open space area to the south of the LSP. Shared paths will be constructed with a minimum width of 2.5 metres.



Due to the low volumes of traffic and the low speed environment on the internal access roads, on-road cycle lanes are not required and cyclists are able to safely share the roadway with motorised vehicles.

5.3. Public Transport

As outlined in Section 2 of this report, the existing Transperth Bus Route 220 currently operates a line haul bus service along Albany Highway within close walking distance to the subject lands with local bus service also provided on Gilwell Avenue. The Kelmscott Railway Station is within 550m walking distance to the lands and provides frequent train service between Armadale Railway Station and the Perth CBD. The existing available public transport services will be able to accommodate the public transport demand associated with the proposed development within the LSP area.

6. ROAD HIERARCHY AND RESERVES

Figure 6 below illustrates the anticipated road classifications for the internal and external road network of the Local Structure Plan. All roads within the LSP area will be classified as *Access Roads (Type C)* or a laneway.

Access Road C would typically consist of a minimum 16 metre reservation to accommodate a 6.0 metre wide central carriageway and 5 metre wide verges on either sides. The verge width is to accommodate the necessary servicing alignments, footpaths, street tree planting and on-street parking bays. A lesser width may be suitable, subject to the approval of the WAPC and City of Armadale, on the proviso that all cross section elements can be included. Lesser road reserve widths adjoining POS shall demonstrate that on-street parking, batters, footpaths, servicing and street tree planting can be contained within the overall reserve width.

Suitable cross section designs should be discussed with the City of Armadale prior to lodgement of any subdivision applications. The final width and alignment of all roads (including the bend on Lot 20) is to be addressed in the detailed subdivision stage.

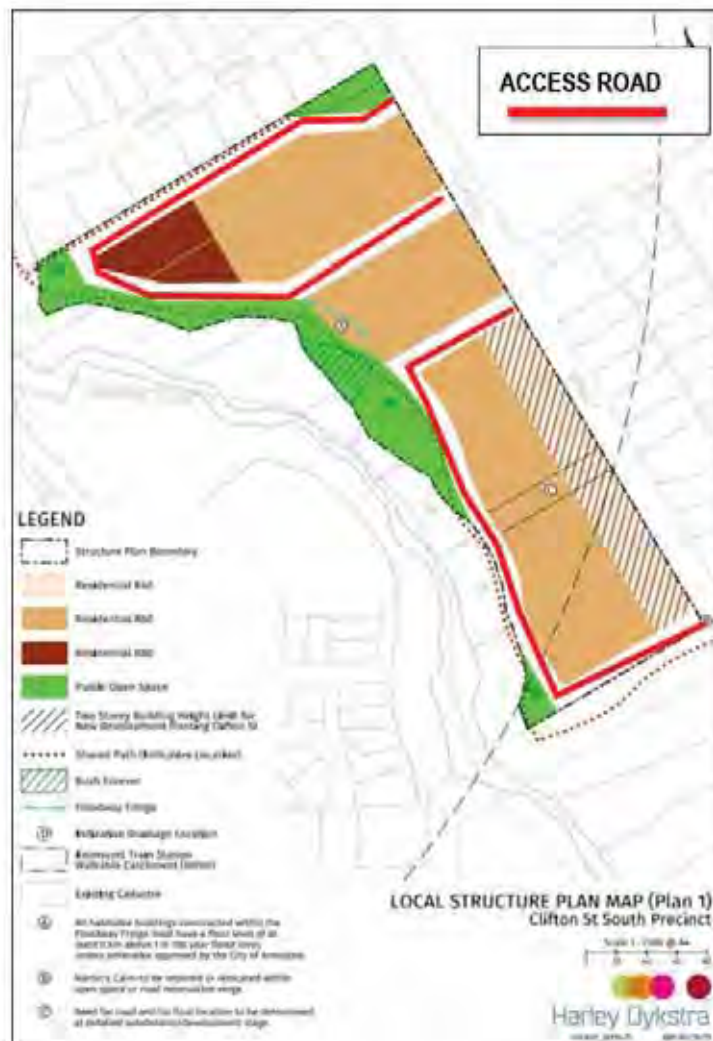


Figure 6: Road Hierarchy – Local Structure Plan Area

7. SUMMARY AND CONCLUSIONS

Shawmac has prepared a Transport Impact Assessment for the proposed Clifton Street South Local Structure Plan area to be located on the west side of Clifton Street, broadly between Gilwell Avenue and Martin Street, Kelmscott, in the City of Armadale. The subject land is located due east of the existing Kelmscott Town Centre and the Kelmscott Railway Station.

Proposed access points to the primary boundary road system to serve the Local Structure Plan consist of four (4) east-west local road connections to the west side of Clifton Street, between Gilwell Avenue and Martin Street with a possibility of a fifth connection, if required. Access will be limited to two full-movements intersections, with the remainder limited to left-in left-out only.

The internal road network is to consist of a series of local access roads which connect to the existing boundary road network in a permeable grid fashion to allow for maximal efficient distribution of locally-generated traffic.

In order to assess the potential traffic impacts associated with the proposed uses detailed in the Local Structure Plan on the boundary road network, a traffic generation and distribution exercise was undertaken. The aim of this exercise was to establish the anticipated traffic volumes which would be generated from the proposed development of the Local Structure Plan in order to quantify the effect that the additional traffic has on the boundary road network.

Based upon the proposed land uses, it has therefore been estimated that the Local Structure Plan area would generate in the order of 2,344 (1,172 inbound/1,172 outbound) vpd on a typical weekday, with approximately 177 (24 inbound/153 outbound) vehicle trips and 214 (171 inbound/43 outbound) vehicle trips during both the a.m. and p.m. weekday peak hours, respectively.

While it is recognised that internal local road traffic volumes along the internal road network are relatively low, in order to minimise conflict and maximise safety within the proposed development, Local Area Traffic Management measures may be implemented. Details relating to line marking, intersection control and local area traffic management measures will be addressed during the detailed subdivision design process.

All roads within the LSP area will be classified as *Access Roads (Type C)* with a minimum 16m road reservation. *Access Road C* would typically consist of a minimum 16 metre reservation to accommodate a 6.0 metre seal and two 5 metre wide verges on both sides to incorporate minimum 1.5 metre wide footpaths. A lesser verge width may be suitable for roads adjoining POS, subject to the approval of WAPC and City of Armadale.

Details associated with the design of any required intersection treatments, including any new and upgraded local road connections to the primary road network will be identified and concept designs will be prepared during the detailed subdivision stages of the development, in consultation with the City of Armadale.

The additional traffic generated by the LSP on a daily basis and the proposed permeable layout of the future development within the area with linkages to the north and east will allow for an efficient distribution of traffic with



the additional traffic comfortably accommodated within the practical road network capacities of the existing road network.

Footpaths should be provided on at least one side of each of the internal local roads with connections to the established pedestrian and cycling network external to the area. It is recommended that all footpaths are constructed with a minimum width of 1.5 metres.

Shared paths provided along the northern, western and southern borders of the site should be constructed with a minimum width of 2.5m.

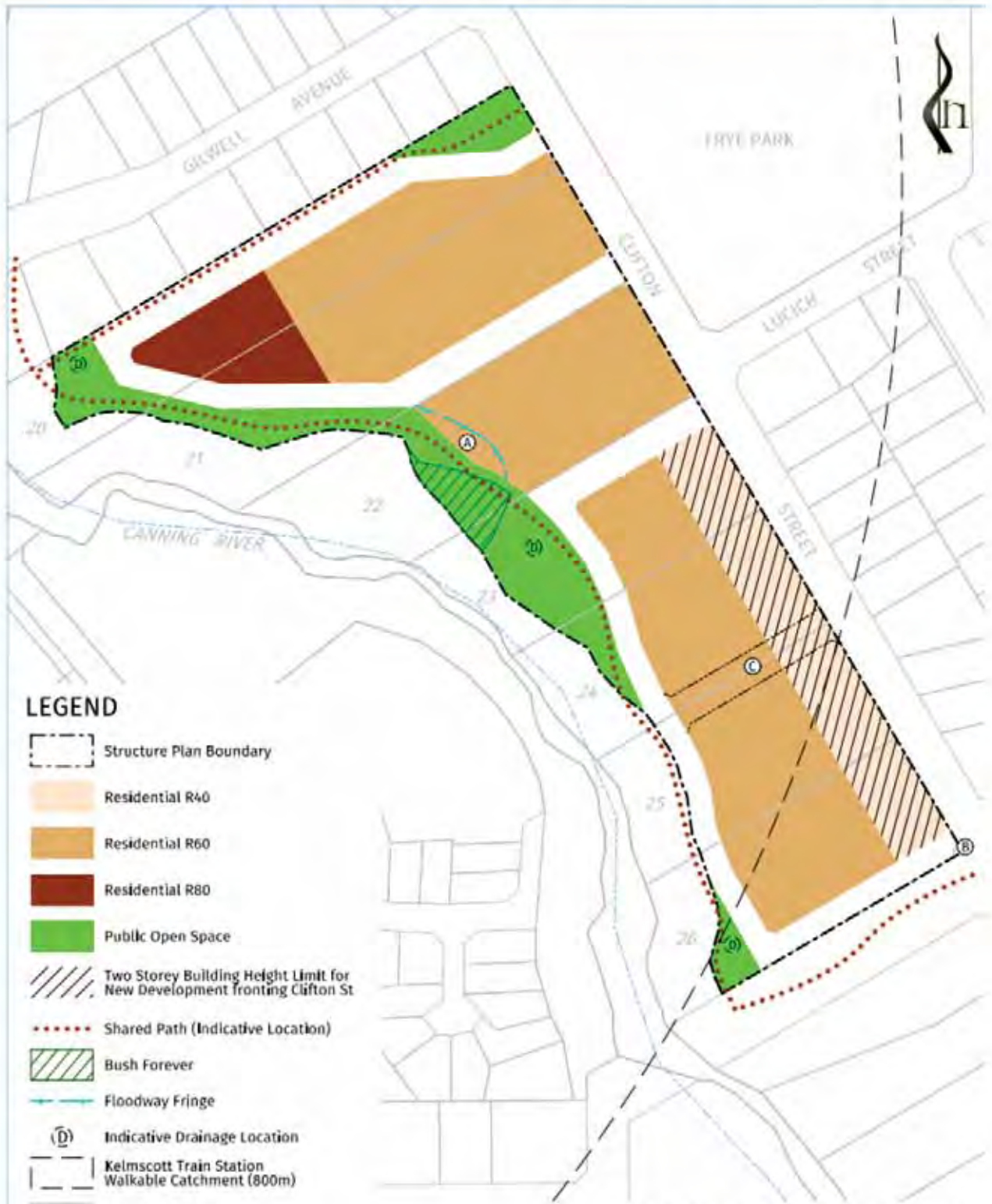
Due to the low volumes of traffic and the low speed environment on the internal access roads, on-road cycle lanes are not required and cyclists are able to safely share the roadway with motorised vehicles.

The existing available public transport services will be able to accommodate the public transport demand associated with the proposed development within the LSP area.

No additional road improvements will be required.



8. APPENDIX A – LOCAL STRUCTURE PLAN



**LOCAL STRUCTURE PLAN MAP (Plan 1)
Clifton St South Precinct**

Scale 1 : 2500 @ A4
0 20 40 60 80

- (A) All habitable buildings constructed within the Floodway Fringe must have a floor level of at least 0.5m above 1 in 100 year flood level, unless otherwise approved by the City of Armadale.
- (B) Martin's Cairn to be retained or relocated within open space or road reservation verge.
- (C) Need for road and/or final location to be determined at detailed subdivision/development stage.



TRAFFIC TECHNICAL NOTE

Subject: Clifton St South Local Structure Plan

Date: 16/09/16

Author: Ed Wilks, Manager - Traffic, Shawmac

Attention: City of Armadale

Shawmac prepared the Transport Impact Assessment submitted with the Local Structure Plan (LSP) for the Clifton St South Precinct. This Technical Note has been prepared to address matters raised by City of Armadale following advertising of the LSP. Specifically, the following traffic matters were identified by the City as requiring further consideration:

- *Traffic impacts on Church Street, Orlando Street, Gilwell Avenue, Page Road, River Road and relevant intersections and traffic counts on roads linking to the aforementioned roads should be modelled and concerns raised regarding Rundle St/Albany Hwy intersection and Lucich St/Clifton St intersection modelled and responded to.*
- *Addressed concerns raised regarding traffic volumes and cumulative volume impacts on Clifton Street, Gilwell Avenue and the surrounding areas. Concerns regarding impacts on and ability for existing bridges to cope with traffic volumes (and any required additional widening) at Orlando Street and Gilwell Avenue. Questions regarding the ability for existing traffic management devices (e.g. Gilwell/Page roundabout and Clifton Street) to cope with projected volumes. Submitters also raised issues regarding additional traffic volume estimated from the remainder of the Structure Plan area and from the proposed aged persons development on Saddlers Retreat.*
- *Concerns regarding pedestrian movement/safety, particularly when walking to/from the Structure Plan area and the Kelmscott Town Centre and nearby schools.*
- *Significant parking demand and traffic associated with Frye Park recreation area and playground (including verge parking, lack of parking bays in recreation carpark) and visibility issues at nearby intersections (Lucich St/Clifton St) and the current usage of vacant land (Lots 20 and 21) used for parking currently.*
- *Complaints regarding traffic queuing, particularly at Gilwell Avenue-Albany Highway intersection.*
- *Many complaints regarding queuing at intersections in the Kelmscott Town Centre including Albany Hwy-Denny Avenue-Streich Avenue [notwithstanding that this may be partly a regional issue, the traffic modelling and advice should indicate the degree to which traffic originating in/accessing the Structure Plan area and impacts upon these congestion points].*
- *References to general area congestion and queries on the local road network's ability to cope with an evacuation event, such as during the 2011 Kelmscott Roleystone Bushfires.*

1.0 Traffic Volumes on Surrounding Road Network

It was agreed that the traffic generation and distribution previously prepared be revised to include the traffic from the entire Clifton St Urban Development area (North, Central and South) and the extent of the surrounding road network to be assessed for potential impacts from the additional traffic be increased to include the roads and intersections for which public concerns were raised. Updated traffic flow data was obtained from City of Armadale (refer **Annexure A**).

The current LSP for the Clifton St South precinct was obtained from Harley Dykstra (refer **Annexure B**). The estimated traffic generation from the proposed Saddlers Retreat Aged Care facility, based on 150 beds is 11 vehicles in and 22 vehicles out during the PM peak hour (based on ITE Guide to trip generation). Assuming a 50/50 split north/south, the additional traffic from the facility is negligible in comparison to the traffic generated by the entire Clifton St Precinct. The peak traffic generation time for the facility would be around midday when the staff change over occurs – which is outside the surrounding peak hour.

The trip generation and distribution of traffic onto the road network was determined and reviewed by City of Armadale (refer **Annexure C**).

1.1 Road Capacities

The Main Roads Western Australia (Main Roads WA) road hierarchy for the surrounding road network is shown in **Figure 1**. Forecast traffic volumes on surrounding roads and desirable maximum volumes in accordance with MRWA road hierarchy are shown in **Table 1** below.



Figure 1: MRWA Road Hierarchy

The above information indicates that the road network immediately surrounding the LSP has the capacity to accommodate the increased road traffic. This would include the likes of Lucich St and Martin St. No traffic flow data was provided by the City for Rundle St and the Albany Hwy/Rundle St intersection has not been modelled. Future traffic volumes on Gilwell Ave will be high, however, the intersections with Page Rd and Clifton St will continue to operate satisfactorily as shown in **Table 2**. This indicates that Gilwell Ave will be able to accommodate the increased traffic volume, however consideration should be given to the upgrading of Gilwell Ave in the future to cater for any further development in the area.

| Road Name | Classification | Desirable Maximum Volume | Existing Volume | Forecast Traffic Volume |
|-----------------------------|---------------------|--------------------------|-----------------|-------------------------|
| Clifton St N of Gilwell Ave | Local Distributer | 7,000 | 2,694 | 6,592 |
| Clifton St S of Gilwell Ave | Local Distributer | 7,000 | 2,678 | 4,708 |
| Gilwell Ave E of Albany Hwy | Local Distributer | 7,000 | 3,675 | 9,053 |
| Gilwell Ave F of Page Rd | Local Distributer | 7,000 | 5,177 | 10,640 |
| Page Rd N of Gilwell Ave | Local Distributer | 7,000 | 2,454 | 2,554 |
| Page Rd S of Gilwell Ave | Local Distributer | 7,000 | 1430 | 1,530 |
| Church St | Local Distributer | 7,000 | 1,755 | 2,155 |
| River Rd | Local Distributer | 7,000 | 2,695 | 3,095 |
| Orlando St | Local Distributer | 7,000 | 4,397 | 4,797 |
| Albany Hwy N of Page Rd | Primary Distributer | >35,000 | 29,812 | 32,318 |
| Albany Hwy N of Gilwell Ave | Primary Distributer | >35,000 | 29,812 | 32,318 |
| Albany Hwy N of Church St | Primary Distributer | >35,000 | 29,812 | 32,684 |
| Albany Hwy S of Church St | Primary Distributer | >35,000 | 29,812 | 33,084 |
| Connell Avenue | Local Distributer | 7,000 | 2,285 | 2,725 |

Table 1: Road Capacities and Forecast Traffic Volumes

1.2 Likely Development Staging and Impacts on Traffic Generation

The development of the Clifton St South LSP area is likely to occur progressively and in a staged manner across the course of the next 10 to 15 years. The initial stage of development is also not anticipated to commence within the next two years, given the typical timeframes associated with the securing of the necessary land use planning and subdivision approvals.

Full traffic generation will only occur upon full development of the LSP area, which is likely to take place across the course of approximately the next 15 years, rather than occurring at the time of the approval of the LSP or the initial stages of development. Allowance has also been made in the yield numbers and traffic modelling for the redevelopment of the existing Belrose Rive Gardens Aged Care facility, which may not occur for a considerable period of time (if at all). On this basis, the ultimate traffic generation may be less than that modelled. It is reiterated that the existing road network has sufficient capacity to accommodate the ultimate modelled traffic generation upon full development (including the Belrose facility).

With development occurring in a staged manner, the generation of additional vehicle traffic as a result of the development of the LSP area is also likely to be incremental across the course of time. Because of this, the impacts associated with additional incremental increases in traffic are not considered likely to be discernible as development proceeds. It is anticipated that minor increases in traffic generation will occur with each stage of development, but that the incremental nature of these increases will not have an evident effect on the existing road network.

Urbanisation and development of the LSP area will occur gradually over many years. Traffic generation associated with development will consequently occur in a staged manner. Full traffic generation will occur on full development of the LSP area, which may take approximately 15 years. The existing road network has sufficient capacity to accommodate the modelling traffic generation on full development of the LSP area.

1.3 Intersection Analysis

SIDRA analysis was carried out on the following intersections and results are included in Annexure D.

SIDRA is a commonly used intersection modelling tool used by traffic engineers for all types of intersections. Outputs for four standard measures of operation performance can be obtained, being Degree of Saturation (DoS), Average Delay, Queue Length, and Level of Service (LoS).

- Degree of Saturation is a measure of how much physical capacity is being used with reference to the full capability of the particular movement, approach, or overall intersection. A DoS of 1.0 equates to full theoretical capacity although in some instances this level is exceeded in practice. SIDRA uses maximum acceptable DoS of 0.90 for signalised intersections for its Design Life analysis. Design engineers typically set a maximum DoS threshold of 0.95 for new intersection layouts or modifications.
- Average Delay reports the average delay per vehicle in seconds experienced by all vehicles in a particular lane, approach, or for the intersection as a whole. For severely congested intersections the average delay begins to climb exponentially.
- Queue Length measures the length of approach queues. In this document we have reported queue length in terms of the length of queue at the 95th percentile (the maximum queue length that will not be exceeded for 95 percent of the time). Queue lengths provide a useful indication of the impact of signals on network performance. It also enables the traffic engineer to consider the likely impact of queues blocking back and impacting on upstream intersections and accesses.
- Level of Service is a combined appreciation of queuing incidence and delay time incurred, producing an alphanumeric ranking of A through F. A LoS of A indicates an excellent level of service whereby drivers delay is at a minimum and they clear the intersection at each change of signals or soon after arrival with little if any queuing. Values of B through D are acceptable in normal traffic conditions. Whilst values of E and F are typically considered undesirable, within central business district areas with significant vehicular and pedestrian numbers, corresponding delays/queues are unavoidable and hence, they are still generally accepted by road users.

| Intersection | Lowest Level of Service | Acceptable |
|------------------------|-------------------------|------------|
| Albany Hwy/Page Rd | D | Yes |
| Albany Hwy/Gilwell Ave | C | Yes |
| Gilwell Ave/Page Rd N | B | Yes |
| Gilwell Rd/Page Rd S | D | Yes |
| Gilwell Ave/Clifton St | B | Yes |
| Albany Hwy/Church St | F | No |
| Church St/River Rd | A | Yes |
| River Rd/Orlando St | A | Yes |
| Orlando St/Clifton St | A | Yes |

Table 2: Results of Intersection Analysis

1.3.1 Albany Hwy/Gilwell Ave

The layout of Albany Hwy/Gilwell Ave intersection is shown in **Figure 2**.



Figure 2: Albany Hwy/Gilwell Ave Intersection Layout

Due to the holding space within the median, the intersection was analysed as a staged movement. The lane LoS results from the SIDRA analysis is shown in **Figure 3** which shows that the intersection will operate well within capacity.

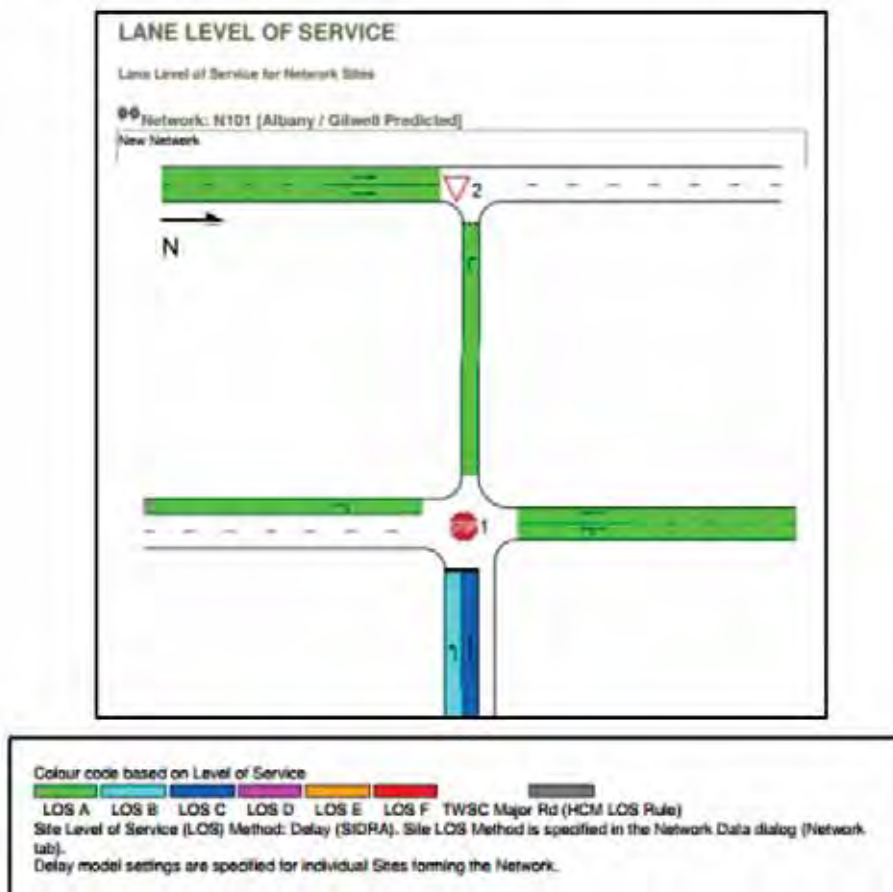


Figure 3: Albany Hwy/Gilwell Ave Intersection – Lane Level of Service

1.3.2 Albany Hwy/Page Road

A SIDRA analysis of the signal controlled intersection of Albany Hwy and Page Rd indicated that this intersection will also operate well within capacity, as shown in Figure 4.

| MOVEMENT SUMMARY | | | | | | | | | | | |
|--|----|-------------------------|------|------------|-------------------|------------------|----------------------------|----------------------------------|-------------|-----------------------------|--------------------|
| Site: 101 [Albany Highway / Page Road] | | | | | | | | | | | |
| New Site | | | | | | | | | | | |
| Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time) | | | | | | | | | | | |
| Variable Sequence Analysis applied. The results are given for the selected output sequence | | | | | | | | | | | |
| Movement Performance - Vehicles | | | | | | | | | | | |
| Mov ID | CD | Demand Flow Total veh/h | HV % | Disp. Satm | Average Delay sec | Level of Service | 10% Back of Queue Vehicles | Average Back of Queue Distance m | Prop Queued | Effective Stop Rate per veh | Average Speed km/h |
| South: Albany Highway | | | | | | | | | | | |
| 2 | T1 | 1591 | 0.0 | 0.526 | 3.6 | LOS A | 11.7 | 81.6 | 0.41 | 0.38 | 56.6 |
| 3 | R2 | 29 | 0.0 | 0.095 | 26.1 | LOS C | 0.7 | 4.8 | 0.89 | 0.70 | 41.2 |
| Approach | | 1617 | 0.0 | 0.526 | 4.0 | LOS A | 11.7 | 81.6 | 0.42 | 0.38 | 56.3 |
| East: Page Road | | | | | | | | | | | |
| 4 | L2 | 29 | 0.0 | 0.093 | 26.1 | LOS C | 0.7 | 4.8 | 0.89 | 0.70 | 41.2 |
| 6 | R2 | 100 | 0.0 | 0.707 | 49.0 | LOS D | 4.2 | 29.6 | 1.00 | 0.65 | 32.6 |
| Approach | | 129 | 0.0 | 0.707 | 44.3 | LOS D | 4.2 | 29.6 | 0.98 | 0.62 | 34.3 |
| North: Albany Highway | | | | | | | | | | | |
| 7 | L2 | 100 | 0.0 | 0.139 | 15.3 | LOS B | 1.7 | 12.2 | 0.68 | 0.71 | 46.6 |
| 8 | T1 | 1516 | 0.0 | 0.813 | 22.7 | LOS C | 27.7 | 193.6 | 0.92 | 0.89 | 43.7 |
| Approach | | 1616 | 0.0 | 0.813 | 22.2 | LOS C | 27.7 | 193.6 | 0.91 | 0.88 | 43.6 |
| All Vehicles | | 3359 | 0.0 | 0.812 | 14.3 | LOS B | 27.7 | 193.6 | 0.67 | 0.64 | 46.6 |

Site Level of Service (LOS) Method: Delay (SIDRA) - See LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement
 Intersection and Approach LOS values are based on average delay for all vehicle movements.
 SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay
 Gap-Acceptance Capacity: SIDRA Standard (Akçelik MGD)
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation

| Movement Performance - Pedestrians | | | | | | | | | | |
|------------------------------------|---------------|----------------------|-------------------|------------------|----------------------------------|----------------------------------|-------------|-----------------------------|--|--|
| Mov ID | Description | Demand Flow per path | Average Delay sec | Level of Service | Average Back of Queue Pedestrian | Average Back of Queue Distance m | Prop Queued | Effective Stop Rate per ped | | |
| P11 | South Stage 1 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 | | |
| P12 | South Stage 2 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 | | |
| P21 | East Stage 1 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 | | |
| P22 | East Stage 2 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 | | |
| All Pedestrians | | 211 | 34.3 | LOS D | | | 0.93 | 0.93 | | |

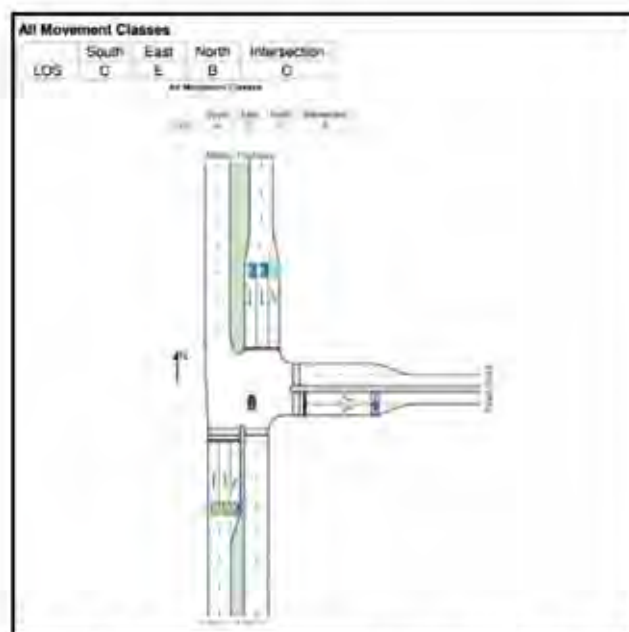


Figure 4: Albany Hwy/Page Rd Intersection – Lane Level of Service

Consideration could be given in the future to the option of attracting more traffic to use Page Rd (north of Gilwell Ave) to access Albany Hwy north bound by improving the configuration of the roundabout at Gilwell Ave/Page Rd to make the right turn movement into Page Rd more convenient for motorists. The SIDRA analysis indicates that the existing roundabout at Gilwell Ave/Page Rd will operate at an acceptable LoS and an upgrade is not required to support the proposed development, however the redirection of more north bound traffic via Page Rd may assist with the potential future modifications to Albany Hwy to address the existing Denny Ave rail crossing issues.

1.3.3 Albany Hwy/Church St

Further analysis of Albany Hwy/Church St intersection was carried out and indicates that the LoS for the right turn movement only from Church St into Albany Hwy is currently F. Post-development, both the right turn movement from Church St into Albany Hwy and the right turn movement into Church St from Albany Hwy will be LoS F. The intersection was also analysed as a signal controlled intersection which indicated the right turn movements to improve to LoS C (refer **Annexure E** for results of analysis).

It is anticipated that the vast majority of northbound traffic that is generated from the development of the LSP area will use either the Gilwell Ave or Page Rd intersections to access Albany Hwy. As detailed in Sections 1.2.1 and 1.2.2, the SIDRA analysis indicates that both of these intersections have spare capacity and would provide easier access to Albany Hwy. Furthermore, both of these intersections are located at the northern end or to the north of the LSP area and it would be logical for local residents to use these intersections to travel north. It is not considered likely the future residents of the LSP area will use the Church St to travel north, as to do so would require residents to firstly travel in the opposite direction before then trying to turn right at Church St. Given the current LoS for this movement, it is considered highly unlikely that residents would choose to use this intersection to travel north, particularly given that there are more convenient options at Gilwell Ave and Page Rd. On this basis, the development of the LSP area is not considered likely to result in any additional traffic impacts at the Church St intersection.

1.3.4 Albany Hwy/Denny Ave/Streich Ave

The congestion within the Kelmscott Centre in the vicinity of Albany Hwy/Denny Ave/Streich Ave is an existing major issue of which the City of Armadale and MRWA are aware. It is understood that MRWA and the Metropolitan Redevelopment Authority, along with the City, have recently commenced a review of the district traffic network covering the Kelmscott area which will determine the future movement network requirements of the locality. Given the importance of the Albany Hwy/Denny Ave/Streich Ave intersection as a crossing of the railway line, it is anticipated that detailed consideration will be given to the requirements of this intersection as part of this district level work. Furthermore, given the district significance of this intersection, existing congestion was considered to be outside the scope of the traffic assessment associated with the LSP area.

2.0 Pedestrian Movement and Safety

The development of the LSP area will result in new footpaths being provided on all local access streets, as well as a new shared path along the future foreshore reserve. The new path network will connect with the existing network, providing excellent access to the Kelmscott Town Centre and Train Station and to other key destinations in the area, including Frye Park and the nearby primary schools. The current and proposed footpath network plan is included in **Annexure F**.

Consideration has been given to the need and locations for pedestrian crossings across the Canning River in the vicinity of the wider Urban Development zoned precinct. Existing pedestrian crossings are provided at Brookside Ave to the north and at Gilwell Ave. It would be logical for an additional crossing to be provided in the area between Gilwell Ave and Brookside Ave, connecting this future development area with Fancote Park. The

requirements and details associated with an additional crossing in the northern precinct will be considered as part of further detailed structure planning for this area.

For the Clifton St South precinct, it is anticipated that the majority of new residents will use the existing pedestrian crossing at Gilwell Ave, due to the direct nature of the link that it provides to the key attractions within the Kelmscott Town Centre (i.e. Train Station, Stargate Shopping Centre, Fancote Park etc) which are generally located nearby to the west and north of the LSP area.

An additional pedestrian crossing of the Canning River, if deemed necessary, would logically be located at the southern end of the LSP area and in the vicinity of the unconstructed Martin St road reserve. Such a connection would most likely link to the corner of Fancote St and River Rd and would provide access along River Rd south to the Kelmscott Primary School and Rushton Park. There are, however, existing heritage considerations (i.e. Martin's Crossing and Three Logs) that would need to be taken into account if a new formalised pedestrian crossing was to be provided in this location. There would also need to be consideration given to management of vegetation in this area of the Canning River to ensure that a potential connection in this location was perceived by the local community as being safe. The density of the vegetation in this area result in the area not being particularly well surveilled.

It is also noted that the existing footpath on the western side of Clifton St extends south of the LSP area links and with Orlando St, which has an existing pedestrian crossing over the Canning River and provides reasonably direct and convenient access to the Kelmscott Primary School and Rushton Park. This existing pedestrian connection is in good condition and is also well surveilled by existing residential development along Clifton St and by passing vehicle traffic.

It may therefore be difficult to effectively and efficiently provide an additional crossing in the vicinity of the Martin St unconstructed road reserve due to the heritage and safety/surveillance considerations outlined above. The need for an additional connection is also questionable, given the existence of the current safe and efficient Clifton St/Orlando St link and crossing.

3.0 Parking at Frye Park

Development occurring within the LSP area shall be obliged to meet its own car parking requirements on-site, in accordance with the R-Codes, WAPC Liveable Neighbourhoods Policy and City of Armadale requirements and will therefore not place any additional load upon the carparking provided at Frye Park.

4.0 Capability of Local Road Network in Emergency Situations

The existing local road network provides a number of options for existing and future local residents to evacuate the area in the event of an emergency situation (i.e. bushfire). **Annexure G** outlines the key roads in the Clifton Hills/Kelmscott locality and demonstrates that there are multiple options available for evacuation if required.

There are several alternatives available for emergency exit depending on the details of the emergency event (i.e. extent of affected area, which streets are closed, and which direction traffic is required travel). Some hypothetical examples are provided as follows, based on potential emergency events occurring in certain locations:

- North (bushland north of Turner Rd) – potentially evacuate to the west via Gilwell Ave (and potentially River Rd/Fancote St or Page Rd)/Albany Hwy, south via Clifton St/Orlando St/River Rd/Rundle

St/Albany Hwy and east via Clifton St/Canning Mills Rd/Grade Rd/Buckingham Rd/Mount St/Brookton Hwy.

- East (bushland east of Ashley Dr) – potentially evacuate to the north via Clifton St/Brookside Ave/Connell Ave or Lucich St/Connell Ave, west via Gilwell Ave (and potentially River Rd/Fancote St or Page Rd)/Albany Hwy and south via Clifton St/Orlando St/River Rd/Rundle St/Albany Hwy.
- West (Canning River vegetation adjacent to LSP area) – potentially evacuate to the north via Clifton St/Brookside Ave/Connell Ave or Lucich St/Connell Ave or east via Clifton St/Canning Mills Rd/Grade Rd/Buckingham Rd/Mount St/Brookton Hwy. Potential to cross the Canning River at Gilwell Ave or Orlando St dependent on location of emergency event.
- South (Canning River vegetation south of Roberts Rd) – potentially evacuate to the north via Clifton St/Brookside Ave/Connell Ave or Lucich St/Connell Ave or west via Gilwell Ave (and potentially River Rd/Fancote St or Page Rd)/Albany Hwy.

It is evident from the examples above that there are multiple evacuation route options currently available in the Clifton Hills/Kelmscott area that can be utilised by existing and future residents in an emergency event. The suitability of particular routes will depend on the actual nature of an applicable emergency event, however it is apparent that there are numerous options which can be used, meaning residents should be able to evacuate the area even if one of the potential options cannot be utilised.

It is also noted that the City of Armadale has a manual of Local Emergency Management Arrangements (LEMA) that outlines principles and processes for the management of emergency situations, including evacuations and arrangements between relevant agencies such as the WA Police, the Department of Fire and Emergency Services, the Department of Parks and Wildlife, Main Roads WA and the City. It is understood that the City's current LEMA (2011) is currently being reviewed and updated.

Additionally, the City and the WAPC have an ability to require site specific Local Emergency Management Plans (LEMP) to be prepared for any sensitive land uses (such as Aged or Dependent Persons) within Local Structure Plan areas. A LEMP can be required through conditions of statutory planning approval and can require further planning for site evacuation in the event of an emergency.

There are multiple emergency evacuation options available for existing and future local residents to use in the Clifton Hills/Kelmscott area in the event of an emergency. Cross-government planning for the management of emergency situation is also in place for the City and is currently under review. The consideration of evacuation measures can also be required at subsequent stages in the detailed planning process.

5.0 Conclusion

This Technical Note has identified the following:

- The road network immediately surrounding the LSP has the capacity to accommodate the increased traffic volumes that will result from the development.
- Development is likely to occur in a staged manner over the course of approximately 15 years and increases in traffic generation will consequently occur incrementally across the development period.
- The Gilwell Ave/Page Rd intersection will operate at an acceptable Level of Service, but consideration could be given to it being upgraded in the future to make the northbound right turn movement from Gilwell Ave to Page Rd more convenient.
- The intersection of Albany Hwy/ Church St currently has a Level of Service F for right turn movements from Church St into Albany Hwy (north bound) and this could deteriorate further. However, there are numerous, more attractive alternative routes available to motorists to access Albany Hwy in a north bound direction and therefore no modifications are recommended for the intersection.
- The current footpath plan adequately caters for safe pedestrian movements within the LSP and immediate surrounds. Consideration could be given to an additional pedestrian crossing of the Canning River in the vicinity of the unconstructed Martin St road reserve, however there are heritage and safety considerations that would need to be addresses if a crossing was to be provided in this location.
- Development within the LSP will be required to provide its own car parking and will therefore not increase parking demand at adjacent Frye Park.
- There are multiple emergency evacuation options available for existing and future local residents to use in the Clifton Hills/Kelmscott area in the event of an emergency.

Connell Avenue traffic data

Daily Classes

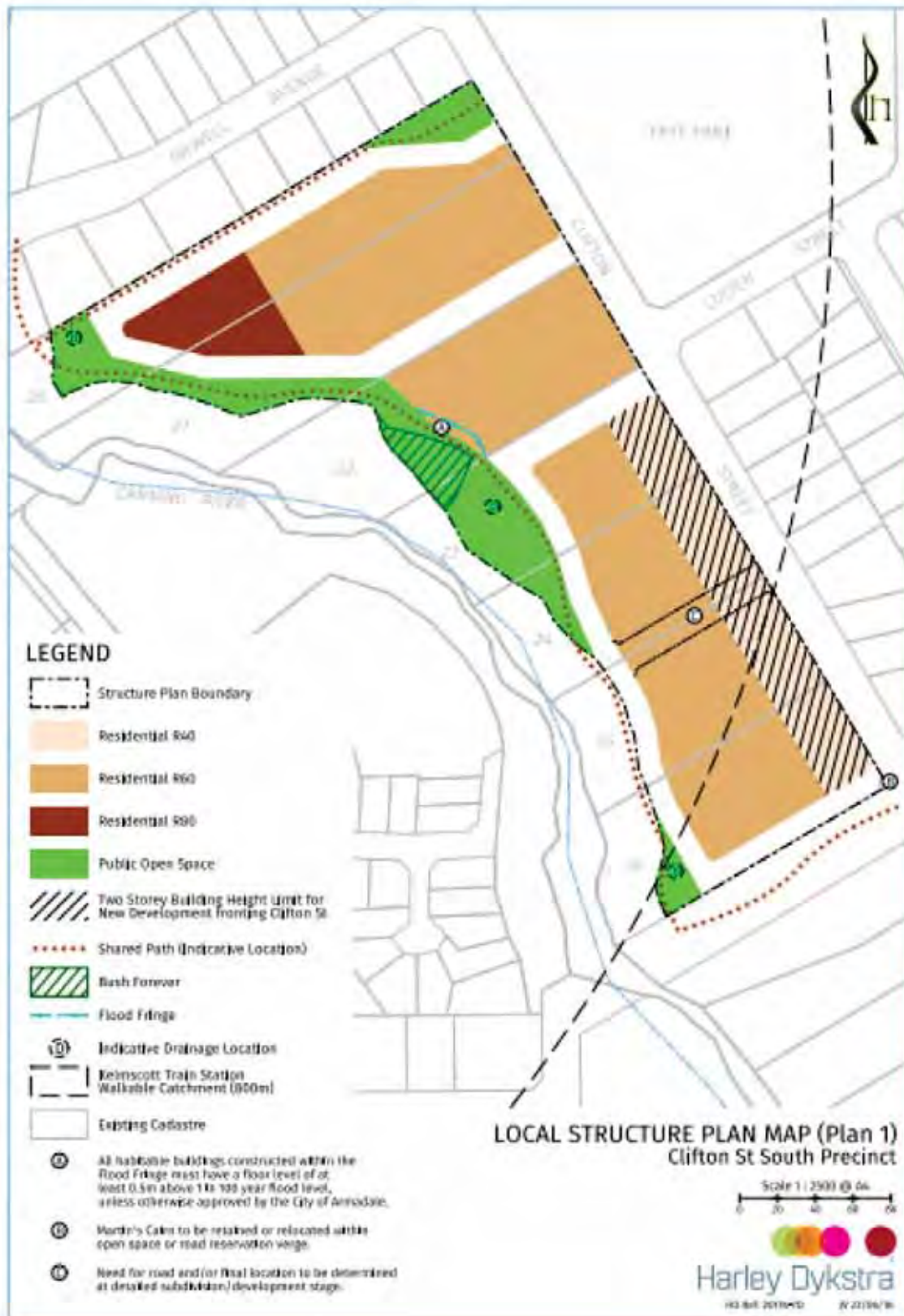
DailyClass-2062
 Site: 15100.0SN
 Description: connell av about 100m sth of turner near no 86
 Filter time: 7:00 Saturday, 11 April 2015 => 7:00 Saturday, 18 April 2015
 Scheme: Vehicle classification (ARX)
 Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Sep(>0)

Average daily volume

| Entire week | | 24 | 2033 | 38 | 58 | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2182 |
|--------------------|-----|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| (%) | 1.1 | 93.2 | 1.6 | 2.7 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Weekdays | | 26 | 2123 | 34 | 65 | 26 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2285 |
| (%) | 1.1 | 92.9 | 1.5 | 2.8 | 1.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Weekend | | 17 | 1583 | 34 | 22 | 9 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1667 |
| (%) | 1.0 | 95.0 | 2.0 | 1.3 | 0.5 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

Annexure B

Clifton St South Local Structure Plan



Annexure C

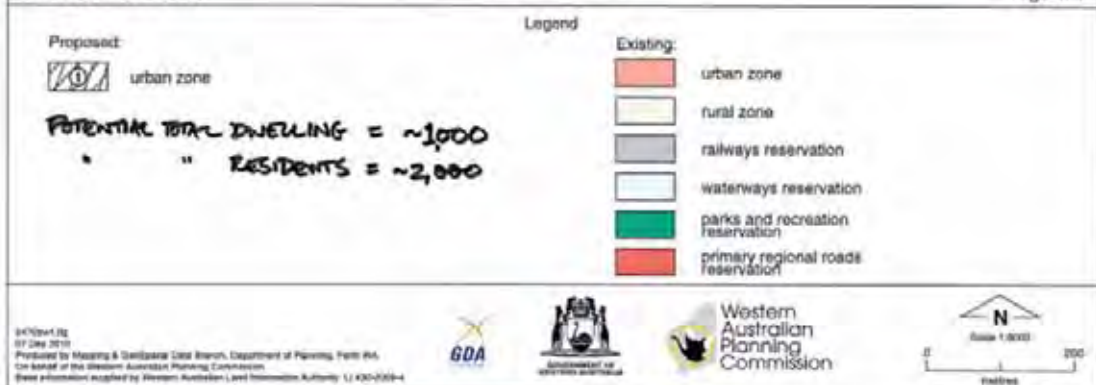
Trip Generation and Distribution



Canning River Precinct Kelmscott - proposed major amendment as advertised

21 September 2010

Figure 1



| Clifton Street South - Estimated trip generation | | | |
|---|---------------------|-------------------|------------------|
| LSP | Lots | Rate | Trips |
| North | 363 | 8 | 2904 |
| Central | 350 | 8 | 2800 |
| South | 386 | 8 | 3088 |
| | | | 8792 |
| | | | |
| | | | |
| External Station | % Attraction | Attraction | |
| Albany Hwy (nth Page) | 35% | 3077 | |
| Page st intersection | 45% | 3956 | |
| Gilwell Street | | 0 | |
| Fancote St | | 0 | |
| Albany Hwy (sth Church) | | 0 | |
| Orlando St (East of Clifton) | 5% | 440 | |
| Connell Ave | 15% | 1319 | |
| | | | |
| | | | |
| Road | Existing | Additional | Predicted |
| Albany Hwy north of Page | 29812 | 2506 | 32318 |
| Albany Hwy north of Gilwell | 29812 | 2506 | 32318 |
| Albany Hwy north of Fancote | 29812 | 2872 | 32684 |
| Albany Hwy north of Church | 29812 | 2872 | 32684 |
| Albany Hwy south of Church | 29812 | 3272 | 33084 |
| Church St | 1755 | 400 | 2155 |
| River Road | 2695 | 400 | 3095 |
| Orlando St | 4397 | 400 | 4797 |
| Clifton St south of Gilwell | 2678 | 2030 | 4708 |
| Clifton St north of Gilwell | 2694 | 3898 | 6592 |
| Page Rd south of Gilwell | 1430 | 100 | 1530 |
| Page Rd north of Gilwell | 2454 | 100 | 2554 |
| Gilwell Street east of Albany Hwy | 3675 | 5378 | 9053 |
| Gilwell Street east of Page Rd | 5177 | 5463 | 10640 |
| | | | |

Annexure D

SIDRA Results of Intersection Analysis

Albany Highway / Page Road

Aerial Photo



LOS Summary

LANE LEVEL OF SERVICE

Lane Level of Service

 Site: 101 [Albany Highway / Page Road]

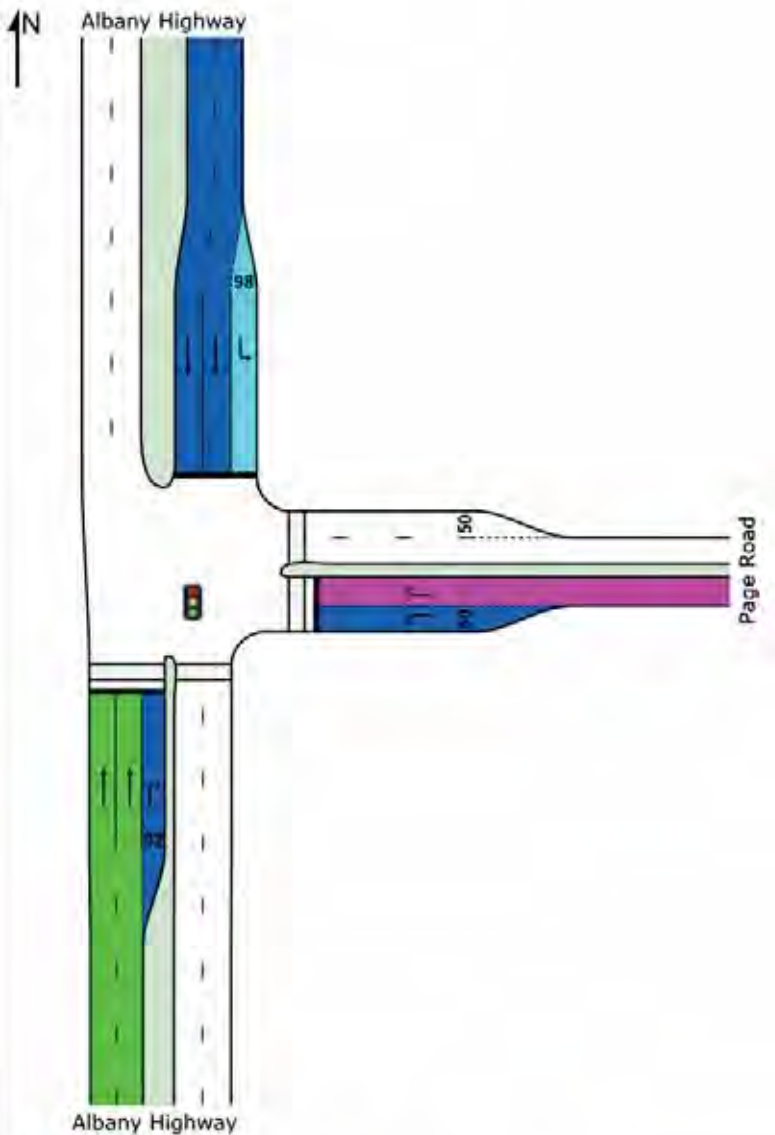
New Site

Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

All Movement Classes

| | South East North Intersection | | | |
|-----|-------------------------------|---|---|---|
| LOS | A | D | C | B |
| | | | | |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

MOVEMENT SUMMARY

Site: 101 [Albany Highway / Page Road]

New Site

Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows Total veh/h | Deg. Satn HV % | Average Delay sec | Level of Service | 95% Back of Queue Vehicles veh | Distance m | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|-----------------------|--------|-----------------------------|-------------------|----------------------|------------------|--------------------------------------|---------------|--------------|--------------------------------|-----------------------|
| South: Albany Highway | | | | | | | | | | |
| 2 | T1 | 1591 | 0.0 0.526 | 3.6 | LOS A | 11.7 | 81.6 | 0.41 | 0.38 | 56.6 |
| 3 | R2 | 26 | 0.0 0.095 | 26.1 | LOS C | 0.7 | 4.8 | 0.89 | 0.70 | 41.2 |
| Approach | | 1617 | 0.0 0.526 | 4.0 | LOS A | 11.7 | 81.6 | 0.42 | 0.38 | 56.3 |
| East: Page Road | | | | | | | | | | |
| 4 | L2 | 26 | 0.0 0.093 | 26.1 | LOS C | 0.7 | 4.8 | 0.89 | 0.70 | 41.2 |
| 6 | R2 | 100 | 0.0 0.707 | 49.0 | LOS D | 4.2 | 29.6 | 1.00 | 0.85 | 32.9 |
| Approach | | 126 | 0.0 0.707 | 44.3 | LOS D | 4.2 | 29.6 | 0.98 | 0.82 | 34.3 |
| North: Albany Highway | | | | | | | | | | |
| 7 | L2 | 100 | 0.0 0.139 | 15.3 | LOS B | 1.7 | 12.2 | 0.68 | 0.71 | 46.9 |
| 8 | T1 | 1516 | 0.0 0.813 | 22.7 | LOS C | 27.7 | 193.6 | 0.92 | 0.89 | 43.7 |
| Approach | | 1616 | 0.0 0.813 | 22.2 | LOS C | 27.7 | 193.6 | 0.91 | 0.88 | 43.9 |
| All Vehicles | | 3359 | 0.0 0.813 | 14.3 | LOS B | 27.7 | 193.6 | 0.67 | 0.64 | 48.6 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

| Mov ID | Description | Demand Flow ped/h | Average Delay sec | Level of Service | Average Back of Queue Pedestrian ped | Distance m | Prop. Queued | Effective Stop Rate per ped |
|-----------------|---------------|----------------------|----------------------|------------------|--|---------------|--------------|--------------------------------|
| P11 | South Stage 1 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P12 | South Stage 2 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P21 | East Stage 1 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| P22 | East Stage 2 | 53 | 34.3 | LOS D | 0.1 | 0.1 | 0.93 | 0.93 |
| All Pedestrians | | 211 | 34.3 | LOS D | | | 0.93 | 0.93 |

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

LANE SUMMARY

Site: 101 [Albany Highway / Page Road]

New Site

Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Lane Use and Performance

| | Demand Flows Total veh/h | HV % veh/h | Cap. | Deg. Satn v/c | Lane Util. % | Average Delay sec | Level of Service | 95% Back of Queue Veh | Dist m | Lane Config | Lane Length m | Prob. Adj. Block. % | Prob. Block. % |
|-----------------------|--------------------------------|---------------|------|------------------|-----------------|----------------------|------------------|--------------------------|-----------|-------------|------------------|------------------------|-------------------|
| South: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 796 | 0.0 | 1511 | 0.526 | 100 | 3.6 | LOS A | 11.7 | 81.6 | Full | 500 | 0.0 | 0.0 |
| Lane 2 | 796 | 0.0 | 1511 | 0.526 | 100 | 3.6 | LOS A | 11.7 | 81.6 | Full | 500 | 0.0 | 0.0 |
| Lane 3 | 26 | 0.0 | 273 | 0.095 | 100 | 26.1 | LOS C | 0.7 | 4.8 | Short | 92 | 0.0 | NA |
| Approach | 1617 | 0.0 | | 0.526 | | 4.0 | LOS A | 11.7 | 81.6 | | | | |
| East: Page Road | | | | | | | | | | | | | |
| Lane 1 | 26 | 0.0 | 279 | 0.093 | 100 | 26.1 | LOS C | 0.7 | 4.8 | Short | 50 | 0.0 | NA |

| | | | | | | | | | | | | | |
|--|------|-----|-----|-------|-----|------|-------|------|-------|-------|-----|-----|-----|
| Lane 2 | 100 | 0.0 | 141 | 0.707 | 100 | 49.0 | LOS D | 4.2 | 29.6 | Full | 500 | 0.0 | 0.0 |
| Approach | 126 | 0.0 | | 0.707 | | 44.3 | LOS D | 4.2 | 29.6 | | | | |
| North: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 100 | 0.0 | 720 | 0.139 | 100 | 15.3 | LOS B | 1.7 | 12.2 | Short | 98 | 0.0 | NA |
| Lane 2 | 755 | 0.0 | 929 | 0.813 | 100 | 22.6 | LOS C | 27.4 | 191.6 | Full | 500 | 0.0 | 0.0 |
| Lane 3 | 761 | 0.0 | 936 | 0.813 | 100 | 22.7 | LOS C | 27.7 | 193.6 | Full | 500 | 0.0 | 0.0 |
| Approach | 1616 | 0.0 | | 0.813 | | 22.2 | LOS C | 27.7 | 193.6 | | | | |
| Intersection | 3359 | 0.0 | | 0.813 | | 14.3 | LOS B | 27.7 | 193.6 | | | | |
| Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab). | | | | | | | | | | | | | |
| Lane LOS values are based on average delay per lane. | | | | | | | | | | | | | |
| Intersection and Approach LOS values are based on average delay for all lanes. | | | | | | | | | | | | | |
| SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay. | | | | | | | | | | | | | |
| Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D). | | | | | | | | | | | | | |
| HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation. | | | | | | | | | | | | | |
| † Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. | | | | | | | | | | | | | |
| ‡ Some upstream delays at entry to short lanes are not included. | | | | | | | | | | | | | |

Albany Highway / Gilwell Avenue

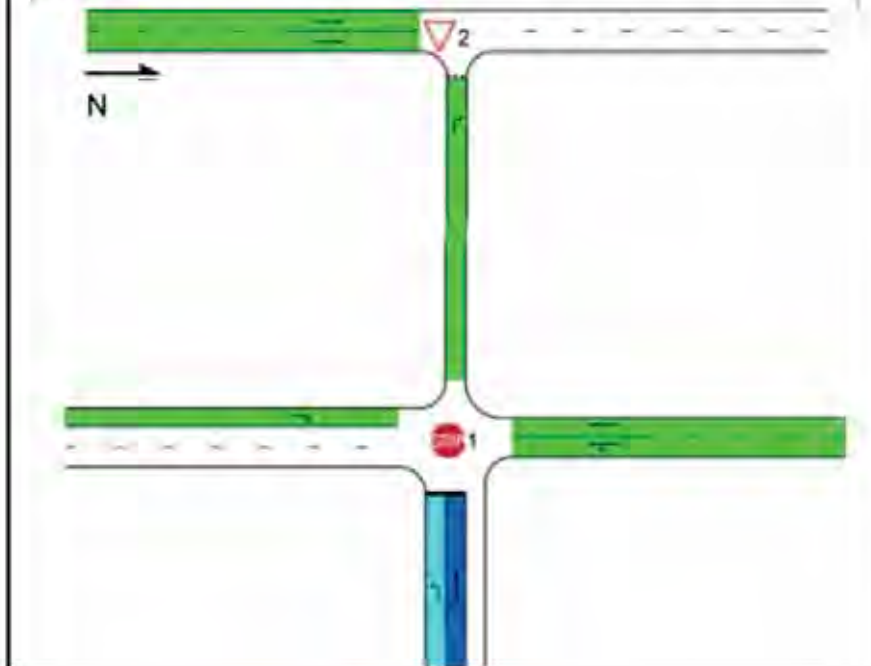


LANE LEVEL OF SERVICE

Lane Level of Service for Network Sites

Network: N101 (Albany / Gilfillan Predicted)

New Network



Colour code based on Level of Service



LOS A LOS B LOS C LOS D LOS E LOS F TWSC Major Rd (HCM LOS Rule)

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Delay model settings are specified for individual Sites forming the Network.

MOVEMENT SUMMARY

Site: 1 [Stop 3-way Stage 1 (Minor Road)]

Network: N101 [Albany / Gilwell Predicted]

L1

Staged crossing Stage 1 (Minor Road) at three-way intersection with 5-lane major road. Major road turn lane is treated as a full-length lane.

Stop (Two-Way)

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Arrival Flows | | Disp Sat | Average Delay | Level of Service | 85% Back of Queue | | Prop. Queued | Effective Stop Rate | Average Speed |
|---------------------------------------|--------|--------------|------|---------------|------|----------|---------------|------------------|-------------------|------------|--------------|---------------------|---------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Vehicles | Distance m | | | |
| South: Gilwell Ave | | | | | | | | | | | | | |
| 1 | L2 | 240 | 0.0 | 240 | 0.0 | 0.301 | 11.9 | LOS B | 1.5 | 10.5 | 0.60 | 0.99 | 49.9 |
| 2 | T1 | 240 | 0.0 | 240 | 0.0 | 0.577 | 24.0 | LOS C | 3.2 | 22.4 | 0.91 | 1.16 | 34.9 |
| Approach | | 480 | 0.0 | 480 | 0.0 | 0.577 | 18.0 | LOS C | 3.2 | 22.4 | 0.75 | 1.07 | 43.6 |
| East: Albany Highway SB | | | | | | | | | | | | | |
| 4 | L2 | 250 | 0.0 | 250 | 0.0 | 0.426 | 5.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.18 | 56.7 |
| 5 | T1 | 1400 | 0.0 | 1400 | 0.0 | 0.426 | 0.1 | LOS A | 0.0 | 0.0 | 0.00 | 0.07 | 59.2 |
| Approach | | 1650 | 0.0 | 1650 | 0.0 | 0.426 | 0.6 | NA | 0.0 | 0.0 | 0.00 | 0.05 | 58.8 |
| West: Albany Highway into Gilwell Ave | | | | | | | | | | | | | |
| 12 | R2 | 250 | 0.0 | 250 | 0.0 | 0.135 | 5.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.58 | 53.6 |
| Approach | | 250 | 0.0 | 250 | 0.0 | 0.135 | 5.6 | NA | 0.0 | 0.0 | 0.00 | 0.58 | 53.6 |
| All Vehicles | | 2380 | 0.0 | 2380 | 0.0 | 0.577 | 4.8 | NA | 3.2 | 22.4 | 0.15 | 0.34 | 55.2 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab)

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 2 [Stop 3-way Stage 2 (Median) L]

Network: N101 [Albany / Gilwell Predicted]

Staged crossing Stage 2 (Median) at three-way intersection with 5-lane major road.

Give-way behaviour assumed at Stage 2.

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Arrival Flows | | Disp Sat | Average Delay | Level of Service | 85% Back of Queue | | Prop. Queued | Effective Stop Rate | Average Speed |
|----------------------------|--------|--------------|------|---------------|------|----------|---------------|------------------|-------------------|------------|--------------|---------------------|---------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Vehicles | Distance m | | | |
| South: Median Storage Area | | | | | | | | | | | | | |
| 3 | R2 | 240 | 0.0 | 240 | 0.0 | 0.187 | 1.8 | LOS A | 0.6 | 3.1 | 0.52 | 0.52 | 50.5 |
| Approach | | 240 | 0.0 | 240 | 0.0 | 0.187 | 1.8 | LOS A | 0.6 | 3.1 | 0.52 | 0.52 | 50.5 |
| West: Albany Highway | | | | | | | | | | | | | |
| 11 | T1 | 1385 | 0.0 | 1385 | 0.0 | 0.355 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 59.9 |
| Approach | | 1385 | 0.0 | 1385 | 0.0 | 0.355 | 0.0 | NA | 0.0 | 0.0 | 0.00 | 0.00 | 59.9 |
| All Vehicles | | 1625 | 0.0 | 1625 | 0.0 | 0.355 | 0.3 | NA | 0.6 | 3.1 | 0.08 | 0.05 | 59.0 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab)

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

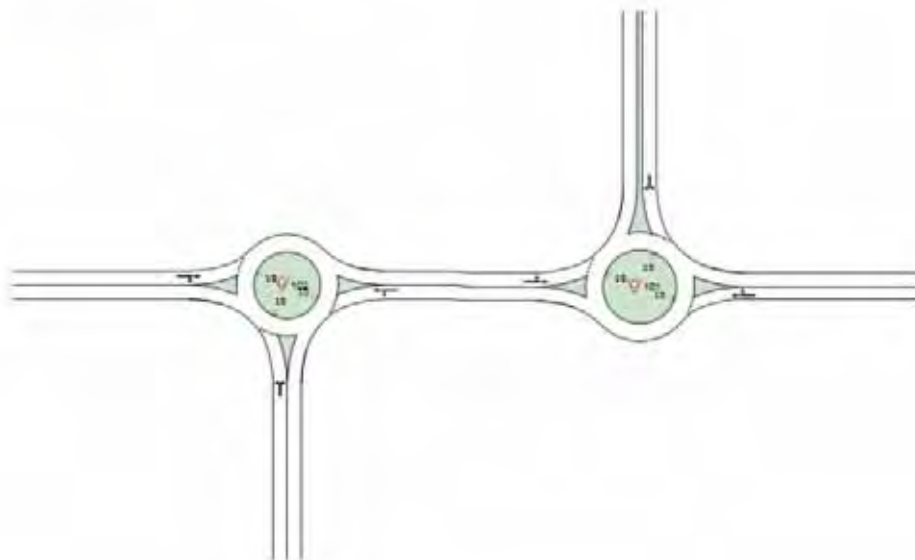
Gilwell Ave / Page Street Roundabout (Modelled as Network)



NETWORK LAYOUT

☐☐ Network: Gilwell / Page Roundabout

New Network:



SITES IN NETWORK

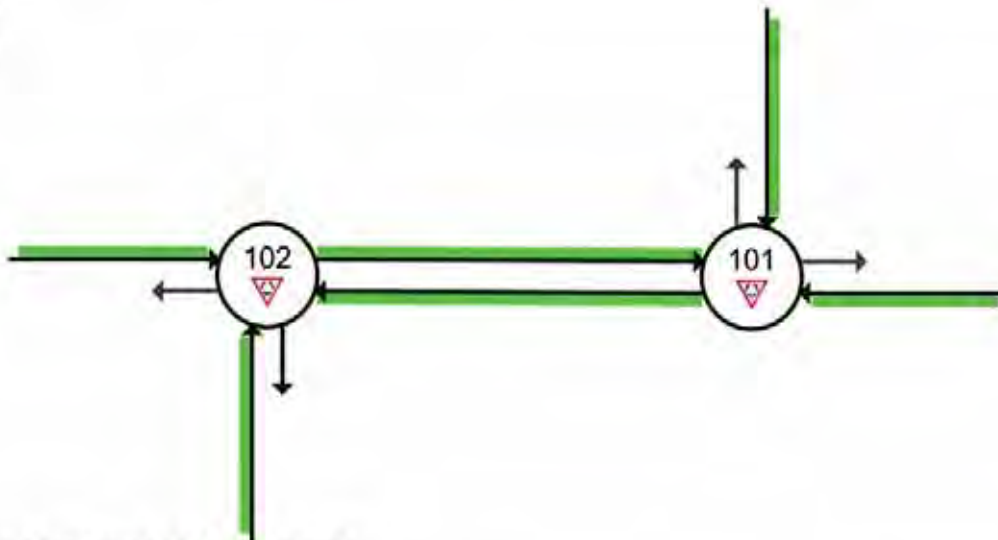
| Site ID | Site Name |
|---------|-------------------------------|
| ▼ 101 | Gilwell Ave / Page Road North |
| ▼ 102 | Gilwell Ave / Page Road South |

APPROACH LEVEL OF SERVICE

Approach Level of Service for Network Sites

☼☼ Network: 1 [Gilwell / Page Roundabout]

New Network



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F TWSC Major Rd (HCM LOS Rule)

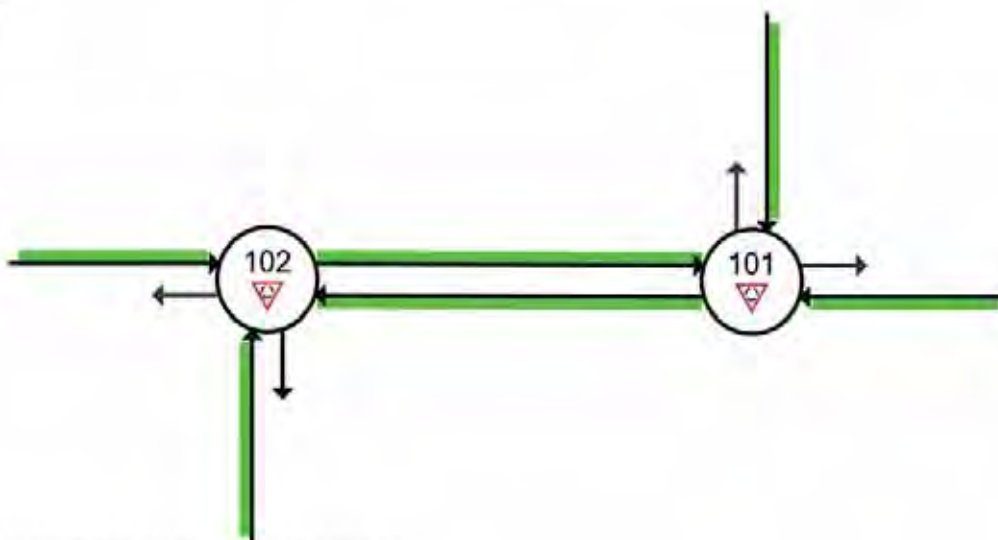
Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (v/c ratio)

☼☼ Network: 1 [Gilwell / Page Roundabout]

New Network



Colour code based on Degree of Saturation

[< 0.6] [0.6 - 0.7] [0.7 - 0.8] [0.8 - 0.9] [0.9 - 1.0] [> 1.0]

LANE LEVEL OF SERVICE

Lane Level of Service

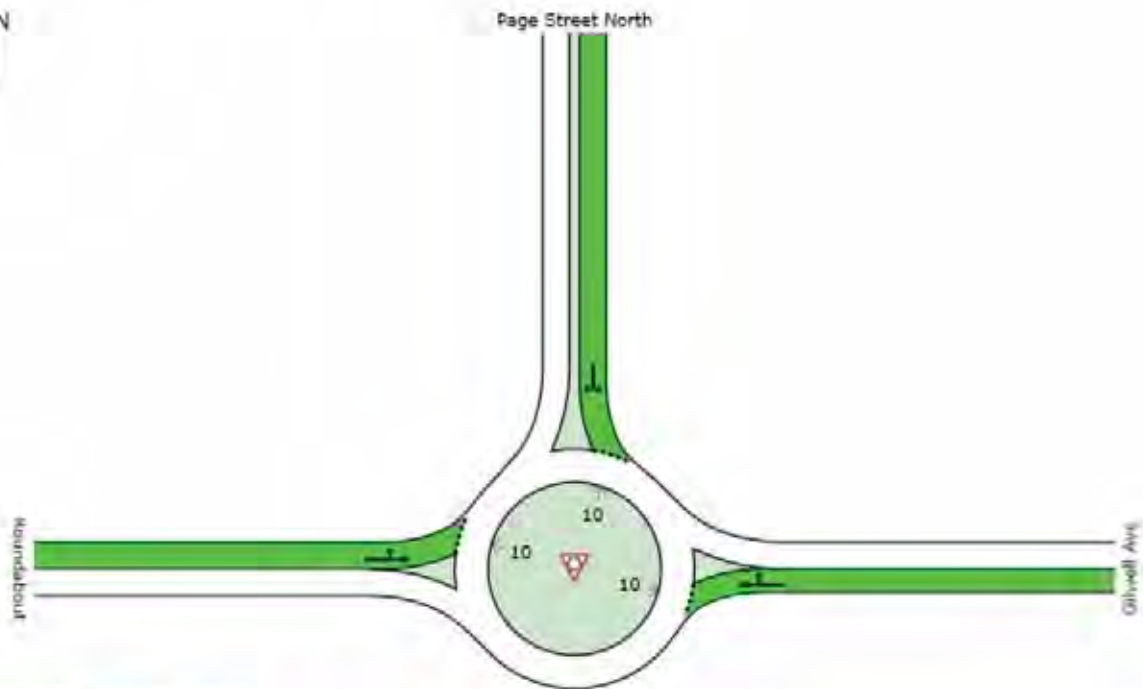
Site: 101 [Gilwell Ave / Page Road North]

New Site

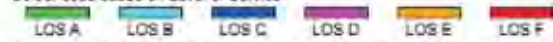
Roundabout

All Movement Classes

| | East | North | West | Intersection |
|-----|------|-------|------|--------------|
| LOS | A | A | A | A |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab)

Roundabout Level of Service Method: Same as Signalised Intersections

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

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Organization: SHAWMAG PTY LTD | Processed: Friday, 18 September 2016 11:27:01 AM

Project: Y/Job Active 2016/T&T - Traffic and Parking/Henry Dykstra (Gilwell Street South 2016)(SIDRA)150916/Collin St L5Psp2

LANE LEVEL OF SERVICE

Lane Level of Service

Site: 102 [Gilwell Ave / Page Road South]

New Site
Roundabout

All Movement Classes

| | South | East | West | Intersection |
|-----|-------|------|------|--------------|
| LOS | A | A | A | A |



Colour code based on Level of Service

| | | | | | |
|-------|-------|-------|-------|-------|-------|
| LOS A | LOS B | LOS C | LOS D | LOS E | LOS F |
|-------|-------|-------|-------|-------|-------|

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Roundabout Level of Service Method: Same as Signalised Intersections

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

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Organization: SHAWMAC PTY LTD | Processed: Friday, 18 September 2016 11:27:01 AM

Project: Y:Ude Active 2016/T&T - Traffic and Parking/Hobby Dyke/ra Ch/Ron Street South 2016/SIDRA/1309/10/G60a-01 (LSP.rpt)

MOVEMENT SUMMARY

Network: 1 [Gilwell / Page Roundabout]

Site: 101 [Gilwell Ave / Page Road North]

New Site
Roundabout

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Arrival Flows | | Deg Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|--------------------------|--------|--------------|------|---------------|------|--------------|-------------------|------------------|-------------------|------------|--------------|-----------------------------|--------------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| East: Gilwell Ave | | | | | | | | | | | | | |
| 5 | T1 | 353 | 0.0 | 353 | 0.0 | 0.344 | 5.4 | LOS A | 2.2 | 15.7 | 0.37 | 0.51 | 49.6 |
| 6 | R2 | 25 | 0.0 | 25 | 0.0 | 0.344 | 8.6 | LOS A | 2.2 | 15.7 | 0.37 | 0.51 | 53.2 |
| Approach | | 378 | 0.0 | 378 | 0.0 | 0.344 | 5.6 | LOS A | 2.2 | 15.7 | 0.37 | 0.51 | 50.0 |
| North: Page Street North | | | | | | | | | | | | | |
| 7 | L2 | 26 | 0.0 | 26 | 0.0 | 0.148 | 6.8 | LOS A | 0.7 | 4.9 | 0.50 | 0.70 | 50.8 |
| 9 | R2 | 100 | 0.0 | 100 | 0.0 | 0.148 | 9.9 | LOS A | 0.7 | 4.9 | 0.50 | 0.70 | 46.3 |
| Approach | | 126 | 0.0 | 126 | 0.0 | 0.148 | 9.3 | LOS A | 0.7 | 4.9 | 0.50 | 0.70 | 47.7 |
| West: Roundabout | | | | | | | | | | | | | |
| 10 | L2 | 100 | 0.0 | 100 | 0.0 | 0.305 | 1.8 | LOS A | 2.1 | 14.4 | 0.15 | 0.41 | 53.1 |
| 11 | T1 | 353 | 0.0 | 353 | 0.0 | 0.305 | 2.1 | LOS A | 2.1 | 14.4 | 0.15 | 0.41 | 54.7 |
| Approach | | 453 | 0.0 | 453 | 0.0 | 0.305 | 2.0 | LOS A | 2.1 | 14.4 | 0.15 | 0.41 | 54.3 |
| All Vehicles | | 957 | 0.0 | 957 | 0.0 | 0.344 | 4.4 | LOS A | 2.2 | 15.7 | 0.28 | 0.49 | 51.5 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay Includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Network: 1 [Gilwell / Page Roundabout]

Site: 102 [Gilwell Ave / Page Road South]

New Site
Roundabout

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Arrival Flows | | Deg Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|--------------------------|--------|--------------|------|---------------|------|--------------|-------------------|------------------|-------------------|------------|--------------|-----------------------------|--------------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| South: Page Street South | | | | | | | | | | | | | |
| 1 | L2 | 50 | 0.0 | 50 | 0.0 | 0.094 | 7.7 | LOS A | 0.5 | 3.4 | 0.58 | 0.70 | 51.1 |
| 3 | R2 | 26 | 0.0 | 26 | 0.0 | 0.094 | 10.8 | LOS B | 0.5 | 3.4 | 0.58 | 0.70 | 46.8 |
| Approach | | 76 | 0.0 | 76 | 0.0 | 0.094 | 8.8 | LOS A | 0.5 | 3.4 | 0.58 | 0.70 | 50.1 |
| East: Roundabout | | | | | | | | | | | | | |
| 4 | L2 | 25 | 0.0 | 25 | 0.0 | 0.379 | 2.0 | LOS A | 2.6 | 18.1 | 0.22 | 0.41 | 52.7 |
| 5 | T1 | 507 | 0.0 | 507 | 0.0 | 0.379 | 2.3 | LOS A | 2.6 | 18.1 | 0.22 | 0.41 | 54.3 |
| Approach | | 532 | 0.0 | 532 | 0.0 | 0.379 | 2.2 | LOS A | 2.6 | 18.1 | 0.22 | 0.41 | 54.2 |
| West: Gilwell Ave | | | | | | | | | | | | | |
| 11 | T1 | 329 | 0.0 | 329 | 0.0 | 0.269 | 4.8 | LOS A | 1.8 | 12.4 | 0.15 | 0.49 | 50.7 |
| 12 | R2 | 50 | 0.0 | 50 | 0.0 | 0.269 | 8.0 | LOS A | 1.8 | 12.4 | 0.15 | 0.49 | 53.8 |
| Approach | | 379 | 0.0 | 379 | 0.0 | 0.269 | 5.2 | LOS A | 1.8 | 12.4 | 0.15 | 0.49 | 51.4 |
| All Vehicles | | 987 | 0.0 | 987 | 0.0 | 0.379 | 3.9 | LOS A | 2.6 | 18.1 | 0.22 | 0.46 | 52.6 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
 Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Network: 1 [Gilwell / Page Roundabout]

Site: 101 [Gilwell Ave / Page Road North]

New Site
 Roundabout

Lane Use and Performance

| | Demand Flows | | Arrival Flows | | Cap. | Deg. Satn | Lane Util. | Average Delay | Level of Service | 95% Back of Queue | | Lane Config | Lane Length | Lane Cap. Adj. | Prob. Block. |
|---------------------------------|--------------|-----|---------------|-----|-------|-----------|------------|---------------|------------------|-------------------|------|-------------|-------------|---------------------|--------------|
| | Total | HV | Total | HV | | | | | | Veh | Dist | | | | |
| | veh/h | % | veh/h | % | veh/h | v/c | % | sec | | | m | m | % | % | |
| East: Gilwell Ave | | | | | | | | | | | | | | | |
| Lane 1 ^d | 378 | 0.0 | 378 | 0.0 | 1099 | 0.344 | 100 | 5.6 | LOS A | 2.2 | 15.7 | Full | 500 | -10.2 ^{N3} | 0.0 |
| Approach | 378 | 0.0 | 378 | 0.0 | | 0.344 | | 5.6 | LOS A | 2.2 | 15.7 | | | | |
| North: Page Street North | | | | | | | | | | | | | | | |
| Lane 1 ^d | 126 | 0.0 | 126 | 0.0 | 852 | 0.148 | 100 | 9.3 | LOS A | 0.7 | 4.9 | Full | 500 | -8.8 ^{N3} | 0.0 |
| Approach | 126 | 0.0 | 126 | 0.0 | | 0.148 | | 9.3 | LOS A | 0.7 | 4.9 | | | | |
| West: Roundabout | | | | | | | | | | | | | | | |
| Lane 1 ^d | 453 | 0.0 | 453 | 0.0 | 1484 | 0.305 | 100 | 2.0 | LOS A | 2.1 | 14.4 | Full | 15 | 0.0 | 3.9 |
| Approach | 453 | 0.0 | 453 | 0.0 | | 0.305 | | 2.0 | LOS A | 2.1 | 14.4 | | | | |
| Intersection | 957 | 0.0 | 957 | 0.0 | | 0.344 | | 4.4 | LOS A | 2.2 | 15.7 | | | | |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Roundabout LOS Method: Same as Signalled Intersections.

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

^d Dominant lane on roundabout approach

^{N3} Capacity Adjustment due to downstream lane blockage determined by the program.

LANE SUMMARY

Network: 1 [Gilwell / Page Roundabout]

Site: 102 [Gilwell Ave / Page Road South]

New Site
 Roundabout

Lane Use and Performance

| | Demand Flows | | Arrival Flows | | Cap. | Deg. Satn | Lane Util. | Average Delay | Level of Service | 95% Back of Queue | | Lane Config | Lane Length | Lane Cap. Adj. | Prob. Block. |
|---------------------------------|--------------|-----|---------------|-----|-------|-----------|------------|---------------|------------------|-------------------|------|-------------|-------------|--------------------|--------------|
| | Total | HV | Total | HV | | | | | | Veh | Dist | | | | |
| | veh/h | % | veh/h | % | veh/h | v/c | % | sec | | | m | m | % | % | |
| South: Page Street South | | | | | | | | | | | | | | | |
| Lane 1 ^d | 76 | 0.0 | 76 | 0.0 | 807 | 0.094 | 100 | 8.8 | LOS A | 0.5 | 3.4 | Full | 500 | -1.4 ^{N3} | 0.0 |
| Approach | 76 | 0.0 | 76 | 0.0 | | 0.094 | | 8.8 | LOS A | 0.5 | 3.4 | | | | |
| East: Roundabout | | | | | | | | | | | | | | | |
| Lane 1 ^d | 532 | 0.0 | 532 | 0.0 | 1404 | 0.379 | 100 | 2.2 | LOS A | 2.6 | 18.1 | Full | 15 | 0.0 | 10.8 |
| Approach | 532 | 0.0 | 532 | 0.0 | | 0.379 | | 2.2 | LOS A | 2.6 | 18.1 | | | | |
| West: Gilwell Ave | | | | | | | | | | | | | | | |
| Lane 1 ^d | 379 | 0.0 | 379 | 0.0 | 1410 | 0.269 | 100 | 5.2 | LOS A | 1.8 | 12.4 | Full | 500 | -3.4 ^{N3} | 0.0 |
| Approach | 379 | 0.0 | 379 | 0.0 | | 0.269 | | 5.2 | LOS A | 1.8 | 12.4 | | | | |
| Intersection | 987 | 0.0 | 987 | 0.0 | | 0.379 | | 3.9 | LOS A | 2.6 | 18.1 | | | | |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Roundabout LOS Method: Same as Signalised Intersections.

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

d Dominant lane on roundabout approach

N3 Capacity Adjustment due to downstream lane blockage determined by the program.

Gilwell Ave / Clifton Street



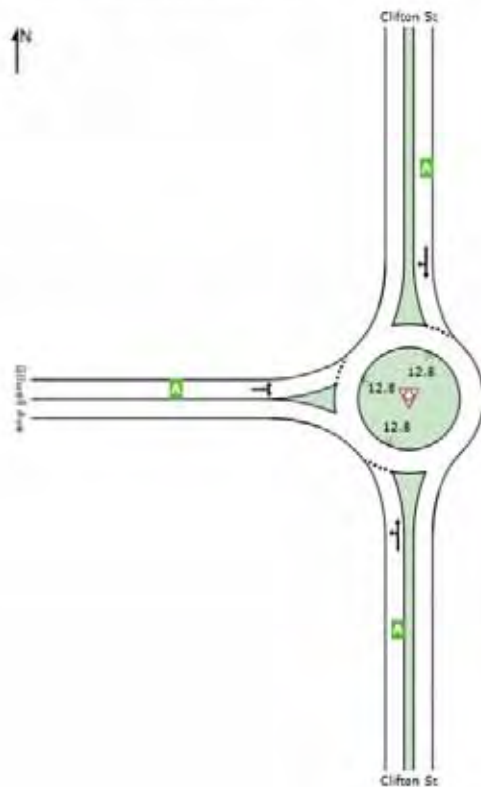
LEVEL OF SERVICE

Site: Gilwell Ave/ Clifton Street

New Site
Roundabout

All Movement Classes

| | South | North | West | Intersection |
|-----|-------|-------|------|--------------|
| LOS | A | A | A | A |



MOVEMENT SUMMARY

 Site: 101 [Gilwell Ave/ Clifton Street]

New Site
Roundabout

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|-------------------|--------|--------------|------|---------------|-------------------|------------------|-------------------|------------|--------------|-----------------------------|--------------------|
| | | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| South: Clifton St | | | | | | | | | | | |
| 1 | L2 | 188 | 0.0 | 0.230 | 5.9 | LOS A | 1.4 | 9.6 | 0.50 | 0.61 | 53.1 |
| 2 | T1 | 47 | 0.0 | 0.230 | 6.1 | LOS A | 1.4 | 9.6 | 0.50 | 0.61 | 54.1 |
| Approach | | 235 | 0.0 | 0.230 | 5.9 | LOS A | 1.4 | 9.6 | 0.50 | 0.61 | 53.3 |
| North: Clifton St | | | | | | | | | | | |
| 8 | T1 | 65 | 0.0 | 0.316 | 6.3 | LOS A | 1.9 | 13.4 | 0.51 | 0.69 | 51.9 |
| 9 | R2 | 265 | 0.0 | 0.316 | 9.9 | LOS A | 1.9 | 13.4 | 0.51 | 0.69 | 51.6 |
| Approach | | 330 | 0.0 | 0.316 | 9.2 | LOS A | 1.9 | 13.4 | 0.51 | 0.69 | 51.7 |
| West: Gilwell Ave | | | | | | | | | | | |
| 10 | L2 | 266 | 0.0 | 0.369 | 4.5 | LOS A | 2.8 | 19.4 | 0.23 | 0.56 | 52.6 |
| 12 | R2 | 266 | 0.0 | 0.369 | 8.5 | LOS A | 2.8 | 19.4 | 0.23 | 0.56 | 53.3 |
| Approach | | 532 | 0.0 | 0.369 | 6.5 | LOS A | 2.8 | 19.4 | 0.23 | 0.56 | 52.9 |
| All Vehicles | | 1097 | 0.0 | 0.369 | 7.2 | LOS A | 2.8 | 19.4 | 0.37 | 0.61 | 52.6 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay Includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY Site: 101 [Gilwell Ave/ Clifton Street]

New Site
Roundabout

Lane Use and Performance

| | Demand Flows | | Cap veh/h | Deg. Satn v/c | Lane Util. % | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Config | Lane Length m | Cap. Adj. % | Prob. Block. % |
|---------------------|--------------|------|-----------|---------------|--------------|-------------------|------------------|-------------------|--------|-------------|---------------|-------------|----------------|
| | Total veh/h | HV % | | | | | | Veh | Dist m | | | | |
| South: Clifton St | | | | | | | | | | | | | |
| Lane 1 ^d | 235 | 0.0 | 1022 | 0.230 | 100 | 5.9 | LOS A | 1.4 | 9.6 | Full | 500 | 0.0 | 0.0 |
| Approach | 235 | 0.0 | | 0.230 | | 5.9 | LOS A | 1.4 | 9.6 | | | | |
| North: Clifton St | | | | | | | | | | | | | |
| Lane 1 ^d | 330 | 0.0 | 1045 | 0.316 | 100 | 9.2 | LOS A | 1.9 | 13.4 | Full | 500 | 0.0 | 0.0 |
| Approach | 330 | 0.0 | | 0.316 | | 9.2 | LOS A | 1.9 | 13.4 | | | | |
| West: Gilwell Ave | | | | | | | | | | | | | |
| Lane 1 ^d | 532 | 0.0 | 1442 | 0.369 | 100 | 6.5 | LOS A | 2.8 | 19.4 | Full | 500 | 0.0 | 0.0 |
| Approach | 532 | 0.0 | | 0.369 | | 6.5 | LOS A | 2.8 | 19.4 | | | | |
| Intersection | 1097 | 0.0 | | 0.369 | | 7.2 | LOS A | 2.8 | 19.4 | | | | |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes.

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay Includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

^d Dominant lane on roundabout approach

Albany Highway / Church St



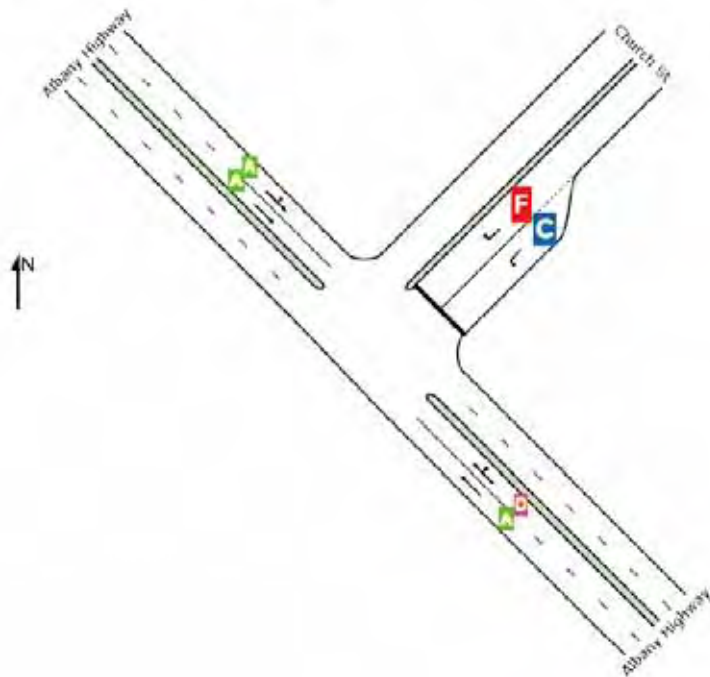
LEVEL OF SERVICE

Site: Albany Highway / Church St

New 5-lr
 Stop (Two-Way)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----|-----------|-----------|-----------|--------------|
| LOS | HA | F | HA | HA |



MOVEMENT SUMMARY

 Site: Albany Highway / Church St

New Site
Stop (Two-Way)

Movement Performance - Vehicles

| Mov ID | ODMo V | Demand Flows | | Deg. Satn V/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---------------------------|-----------|----------------|---------|------------------|-------------------------|---------------------|-------------------|---------------|-----------------|-----------------------------------|--------------------------|
| | | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| SouthEast: Albany Highway | | | | | | | | | | | |
| 22 | T1 | 1585 | 0.0 | 0.621 | 7.4 | LOS A | 12.4 | 87.1 | 0.22 | 0.04 | 53.1 |
| 23 | R2 | 58 | 0.0 | 0.621 | 50.4 | LOS F | 12.4 | 87.1 | 1.00 | 0.16 | 37.9 |
| Approach | | 1643 | 0.0 | 0.621 | 8.9 | NA | 12.4 | 87.1 | 0.25 | 0.04 | 52.4 |
| NorthEast: Church St | | | | | | | | | | | |
| 24 | L2 | 58 | 0.0 | 0.143 | 15.5 | LOS C | 0.5 | 3.3 | 0.70 | 1.00 | 47.7 |
| 26 | R2 | 58 | 0.0 | 9.649 | 8359.6 | LOS F | 51.6 | 361.0 | 1.00 | 1.39 | 0.4 |
| Approach | | 116 | 0.0 | 9.649 | 4187.5 | LOS F | 51.6 | 361.0 | 0.85 | 1.19 | 0.9 |
| NorthWest: Albany Highway | | | | | | | | | | | |
| 27 | L2 | 58 | 0.0 | 0.425 | 5.6 | LOS A | 0.0 | 0.0 | 0.00 | 0.04 | 57.9 |
| 28 | T1 | 1600 | 0.0 | 0.425 | 0.1 | LOS A | 0.0 | 0.0 | 0.00 | 0.02 | 59.7 |
| Approach | | 1658 | 0.0 | 0.425 | 0.3 | NA | 0.0 | 0.0 | 0.00 | 0.02 | 59.6 |
| All Vehicles | | 3417 | 0.0 | 9.649 | 146.3 | NA | 51.6 | 361.0 | 0.15 | 0.07 | 17.7 |

Level of Service (LOS) Method: Delay (HCM 2000).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

 Site: Albany Highway / Church St

New Site
Stop (Two-Way)

Lane Use and Performance

| | Demand Flows | | Cap. Satn | Lane Util. | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Contig. | Lane Length m | Cap. Adj. % | Prob. Block % | |
|---------------------------|----------------|---------|--------------|---------------|-------------------------|---------------------|-------------------|------------|-----------------|---------------------|-------------------|---------------------|-----|
| | Total veh/h | HV % | | | | | Veh | Dist. m | | | | | |
| | | | v/c | % | | | | | | | | | |
| SouthEast: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 1229 | 0.0 | 1980 | 0.621 | 100 | 0.1 | LOS A | 0.0 | 0.0 | Full | 500 | 0.0 | 0.0 |
| Lane 2 | 414 | 0.0 | 666 | 0.621 | 100 | 34.9 | LOS D | 12.4 | 87.1 | Full | 500 | 0.0 | 0.0 |
| Approach | | 1643 | 0.0 | 0.621 | | 8.9 | NA | 12.4 | 87.1 | | | | |
| NorthEast: Church St | | | | | | | | | | | | | |
| Lane 1 | 58 | 0.0 | 404 | 0.143 | 100 | 15.5 | LOS C | 0.5 | 3.3 | Short | 60 | 0.0 | NA |
| Lane 2 | 58 | 0.0 | 6 | 9.649 | 100 | 8359.6 | LOS F | 51.6 | 361.0 | Full | 500 | 0.0 | 0.0 |
| Approach | | 116 | 0.0 | 9.649 | | 4187.5 | LOS F | 51.6 | 361.0 | | | | |
| NorthWest: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 843 | 0.0 | 1984 | 0.425 | 100 | 0.4 | LOS A | 0.0 | 0.0 | Full | 500 | 0.0 | 0.0 |
| Lane 2 | 815 | 0.0 | 1920 | 0.425 | 100 | 0.1 | LOS A | 0.0 | 0.0 | Full | 500 | 0.0 | 0.0 |
| Approach | | 1658 | 0.0 | 0.425 | | 0.3 | NA | 0.0 | 0.0 | | | | |
| Intersection | | 3417 | 0.0 | 9.649 | | 146.3 | NA | 51.6 | 361.0 | | | | |

Level of Service (LOS) Method: Delay (HCM 2000).

Lane LOS values are based on average delay per lane.

Minor Road Approach LOS values are based on average delay for all lanes.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

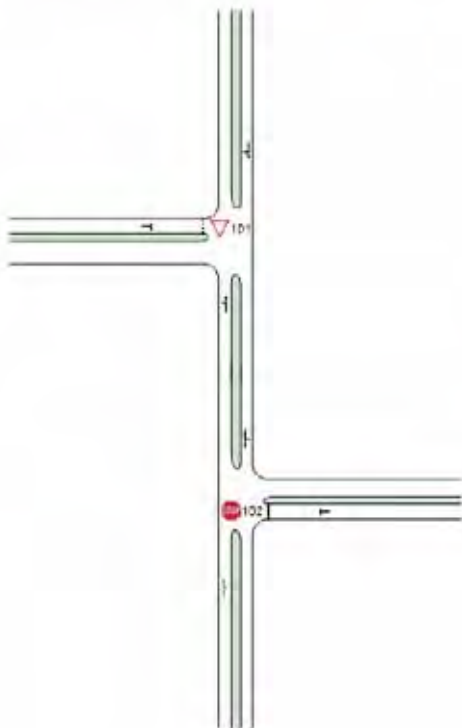
Church St / River St / Orlando St - Modelled as a network



NETWORK LAYOUT

Network: Church / River / Orlando

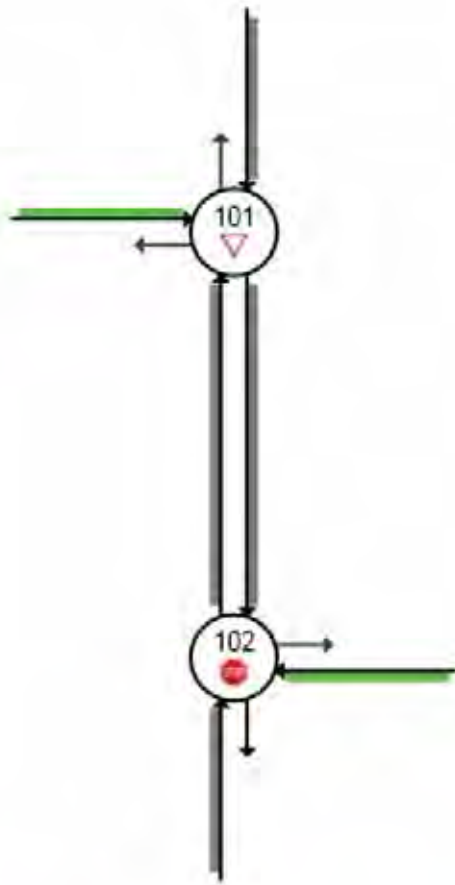
New Network:



SITE LEVEL OF SERVICE

Approach Level of Service for Network Sites

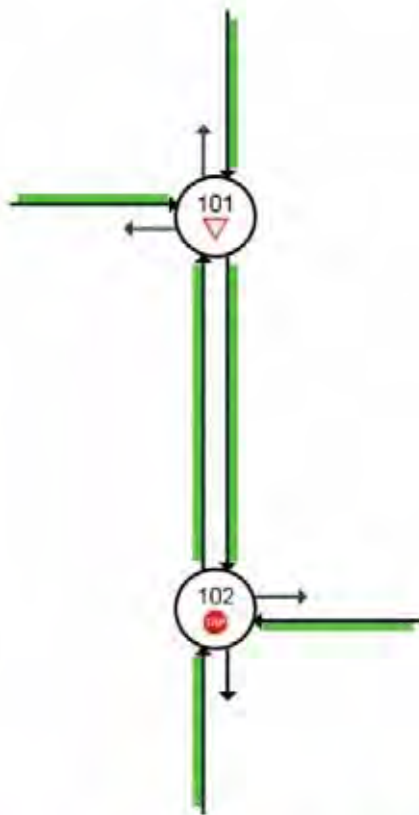
☐☐ Network: Church / River / Orlando



DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (v/c ratio)

☐☐ Network: Church / River / Orlando _____



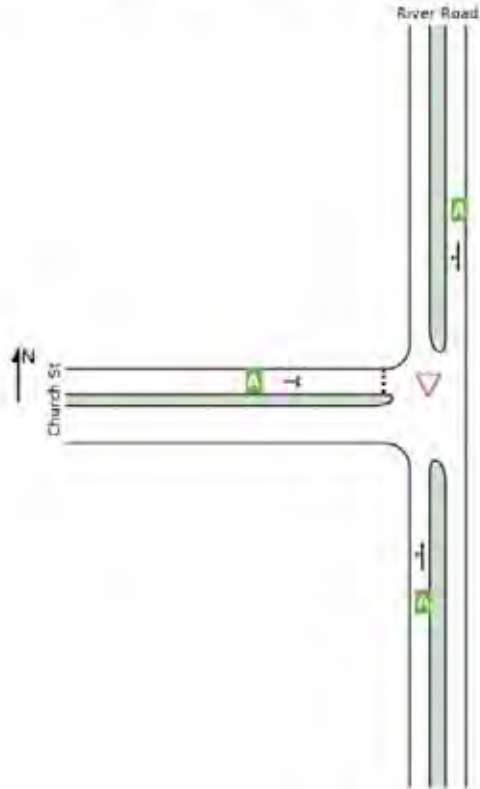
LEVEL OF SERVICE

▽ Site: River Road / Church St

New Site
Gateway / Yield (Two-Way)

All Movement Classes

| | South | North | West | Intersection |
|-----|-------|-------|------|--------------|
| LOS | NA | NA | A | NA |



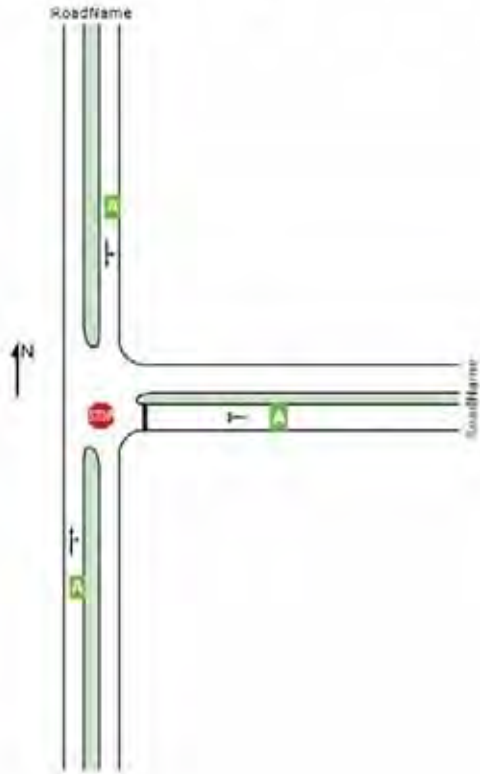
LEVEL OF SERVICE

● Site: River Road / Orlando St

New Site
Stop (Two-Way)

All Movement Classes

| | South | East | North | Intersection |
|-----|-------|------|-------|--------------|
| LOS | NA | A | NA | NA |



MOVEMENT SUMMARY

Site: River Road / Church St

Network: Church / River / Orlando

New Site

Giveaway / Yield (Two-Way)

Movement Performance - Vehicles

| Mov ID | ODMo V | Demand Flows | | Arrival Flows | | Deg. Satn V/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|-------------------|-----------|----------------|---------|----------------|---------|------------------|-------------------------|---------------------|-------------------|-----------|-----------------|-----------------------------------|--------------------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Veh | Dist m | | | |
| South: River Road | | | | | | | | | | | | | |
| 1 | L2 | 53 | 0.0 | 53 | 0.0 | 0.081 | 4.5 | LOS A | 0.0 | 0.0 | 0.00 | 0.19 | 54.9 |
| 2 | T1 | 105 | 0.0 | 105 | 0.0 | 0.081 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.19 | 57.5 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.081 | 1.5 | NA | 0.0 | 0.0 | 0.00 | 0.19 | 56.6 |
| North: River Road | | | | | | | | | | | | | |
| 8 | T1 | 79 | 0.0 | 79 | 0.0 | 0.091 | 0.4 | LOS A | 0.4 | 2.9 | 0.24 | 0.29 | 53.5 |
| 9 | R2 | 79 | 0.0 | 79 | 0.0 | 0.091 | 6.0 | LOS A | 0.4 | 2.9 | 0.24 | 0.29 | 54.9 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.091 | 3.2 | NA | 0.4 | 2.9 | 0.24 | 0.29 | 54.4 |
| West: Church St | | | | | | | | | | | | | |
| 10 | L2 | 58 | 0.0 | 58 | 0.0 | 0.097 | 5.9 | LOS A | 0.4 | 2.5 | 0.23 | 0.57 | 52.9 |
| 12 | R2 | 58 | 0.0 | 58 | 0.0 | 0.097 | 6.7 | LOS A | 0.4 | 2.5 | 0.23 | 0.57 | 49.6 |
| Approach | | 116 | 0.0 | 116 | 0.0 | 0.097 | 6.3 | LOS A | 0.4 | 2.5 | 0.23 | 0.57 | 51.8 |
| All Vehicles | | 432 | 0.0 | 432 | 0.0 | 0.097 | 3.4 | NA | 0.4 | 2.9 | 0.15 | 0.33 | 54.2 |

Level of Service (LOS) Method: Delay (HCM 2000).

Vehicle movement LOS values are based on average delay per movement

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

Site: River Road / Church St

Network: Church / River / Orlando

New Site

Giveaway / Yield (Two-Way)

Lane Use and Performance

| | Demand Flows | | Arrival Flows | | Cap. 1930 | Deg. Satn V/c | Lane Util % | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Config | Lane Length m | Cap. Adj. % | Prob. Block. % |
|-------------------|----------------|---------|----------------|---------|--------------|------------------|----------------|----------------------|------------------|-------------------|-----------|-------------|------------------|----------------|-------------------|
| | Total veh/h | HV % | Total veh/h | HV % | | | | | | Veh | Dist m | | | | |
| | | | | | | | | | | | | | | | |
| South: River Road | | | | | | | | | | | | | | | |
| Lane 1 | 158 | 0.0 | 158 | 0.0 | 1930 | 0.081 | 100 | 1.5 | LOS A | 0.0 | 0.0 | Full | 65 | 0.0 | 0.0 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.081 | | 1.5 | NA | 0.0 | 0.0 | | | | |
| North: River Road | | | | | | | | | | | | | | | |
| Lane 1 | 158 | 0.0 | 158 | 0.0 | 1726 | 0.091 | 100 | 3.2 | LOS A | 0.4 | 2.9 | Full | 500 | 0.0 | 0.0 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.091 | | 3.2 | NA | 0.4 | 2.9 | | | | |
| West: Church St | | | | | | | | | | | | | | | |
| Lane 1 | 116 | 0.0 | 116 | 0.0 | 1190 | 0.097 | 100 | 6.3 | LOS A | 0.4 | 2.5 | Full | 500 | 0.0 | 0.0 |
| Approach | | 116 | 0.0 | 116 | 0.0 | 0.097 | | 6.3 | LOS A | 0.4 | 2.5 | | | | |
| Intersection | | 432 | 0.0 | 432 | 0.0 | 0.097 | | 3.4 | NA | 0.4 | 2.9 | | | | |

Level of Service (LOS) Method: Delay (HCM 2000).

Lane LOS values are based on average delay per lane.

Minor Road Approach LOS values are based on average delay for all lanes.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.


SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

 Site: River Road / Orlando St

 Network: Church / River / Orlando

New Site
Stop (Two-Way)

Movement Performance - Vehicles

| Mov ID | ODMo V | Demand Flows | | Arrival Flows | | Deg. Satn V/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|-----------------|-----------|----------------|---------|----------------|---------|------------------|-------------------------|---------------------|-------------------|---------------|-----------------|-----------------------------------|--------------------------|
| | | Total veh/h | HV % | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| South: RoadName | | | | | | | | | | | | | |
| 2 | T1 | 105 | 0.0 | 105 | 0.0 | 0.088 | 0.3 | LOS A | 0.3 | 2.2 | 0.19 | 0.19 | 55.3 |
| 3 | R2 | 53 | 0.0 | 53 | 0.0 | 0.088 | 6.0 | LOS A | 0.3 | 2.2 | 0.19 | 0.19 | 55.7 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.088 | 2.2 | NA | 0.3 | 2.2 | 0.19 | 0.19 | 55.5 |
| East: RoadName | | | | | | | | | | | | | |
| 4 | L2 | 95 | 0.0 | 95 | 0.0 | 0.245 | 8.2 | LOS A | 1.0 | 7.0 | 0.20 | 0.93 | 51.4 |
| 6 | R2 | 158 | 0.0 | 158 | 0.0 | 0.245 | 9.3 | LOS A | 1.0 | 7.0 | 0.20 | 0.93 | 47.0 |
| Approach | | 253 | 0.0 | 253 | 0.0 | 0.245 | 8.9 | LOS A | 1.0 | 7.0 | 0.20 | 0.93 | 49.3 |
| North: RoadName | | | | | | | | | | | | | |
| 7 | L2 | 105 | 0.0 | 105 | 0.0 | 0.083 | 4.5 | LOS A | 0.0 | 0.0 | 0.00 | 0.38 | 52.8 |
| 8 | T1 | 53 | 0.0 | 53 | 0.0 | 0.083 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.38 | 55.2 |
| Approach | | 158 | 0.0 | 158 | 0.0 | 0.083 | 3.0 | NA | 0.0 | 0.0 | 0.00 | 0.38 | 53.6 |
| All Vehicles | | 568 | 0.0 | 568 | 0.0 | 0.245 | 5.4 | NA | 1.0 | 7.0 | 0.14 | 0.57 | 52.0 |

Level of Service (LOS) Method: Delay (HCM 2000).

Vehicle movement LOS values are based on average delay per movement

Minor Road Approach LOS values are based on average delay for all vehicle movements.


NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.


SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

 Site: River Road / Orlando St

 Network: Church / River / Orlando

New Site
Stop (Two-Way)

Lane Use and Performance

| | Demand Flows | | Arrival Flows | | Cap. 1796 | Deg. Satn V/c | Lane Util % | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Config | Lane Length m | Cap. Adj. % | Prob. Block. % |
|-----------------|----------------|---------|----------------|---------|--------------|------------------|----------------|----------------------|------------------|-------------------|-----------|-------------|------------------|----------------|-------------------|
| | Total veh/h | HV % | Total veh/h | HV % | | | | | | Veh | Dist m | | | | |
| | | | | | | | | | | | | | | | |
| South: RoadName | | | | | | | | | | | | | | | |
| Lane 1 | 158 | 0.0 | 158 | 0.0 | 1796 | 0.088 | 100 | 2.2 | LOS A | 0.3 | 2.2 | Full | 500 | 0.0 | 0.0 |
| Approach | 158 | 0.0 | 158 | 0.0 | | 0.088 | | 2.2 | NA | 0.3 | 2.2 | | | | |
| East: RoadName | | | | | | | | | | | | | | | |
| Lane 1 | 253 | 0.0 | 253 | 0.0 | 1031 | 0.245 | 100 | 8.9 | LOS A | 1.0 | 7.0 | Full | 500 | 0.0 | 0.0 |
| Approach | 253 | 0.0 | 253 | 0.0 | | 0.245 | | 8.9 | LOS A | 1.0 | 7.0 | | | | |
| North: RoadName | | | | | | | | | | | | | | | |
| Lane 1 | 158 | 0.0 | 158 | 0.0 | 1907 | 0.083 | 100 | 3.0 | LOS A | 0.0 | 0.0 | Full | 65 | 0.0 | 0.0 |
| Approach | 158 | 0.0 | 158 | 0.0 | | 0.083 | | 3.0 | NA | 0.0 | 0.0 | | | | |
| Intersection | 568 | 0.0 | 568 | 0.0 | | 0.245 | | 5.4 | NA | 1.0 | 7.0 | | | | |

Level of Service (LOS) Method: Delay (HCM 2000).

Lane LOS values are based on average delay per lane.

Minor Road Approach LOS values are based on average delay for all lanes.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Orlando St / Clifton St



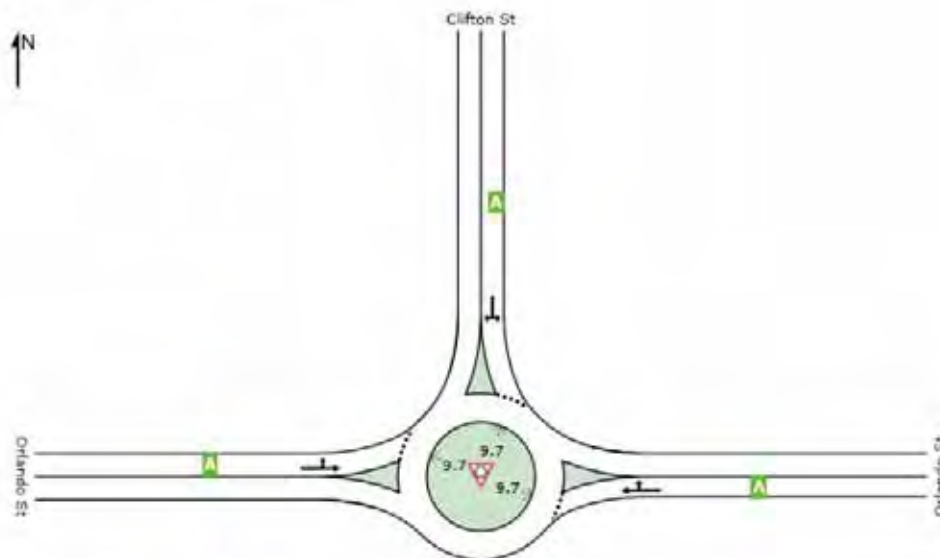
LEVEL OF SERVICE

Site: Orlando St / Clifton St

New Site
Roundabout

All Movement Classes

| | East | North | West | Intersection |
|-----|------|-------|------|--------------|
| LOS | A | A | A | A |



Level of Service (LOS) Method: Delay (HCM 2000)
 Roundabout LOS Method: Same as Signalised Intersections.
 Lane LOS values are based on average delay per lane.
 Intersection and Approach LOS values are based on average delay for all lanes.
 SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

MOVEMENT SUMMARY

 Site: Orlando St / Clifton St

New Site
Roundabout

Movement Performance - Vehicles

| Mov ID | ODMo V | Demand Flows | | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per Veh | Average Speed km/h |
|-------------------|-----------|----------------|---------|------------------|-------------------------|---------------------|-------------------|-----------|-----------------|-----------------------------------|--------------------------|
| | | Total veh/h | HV % | | | | Veh | Dist m | | | |
| East: Orlando St | | | | | | | | | | | |
| 5 | T1 | 190 | 0.0 | 0.225 | 6.2 | LOS A | 1.4 | 9.7 | 0.46 | 0.59 | 53.1 |
| 6 | R2 | 53 | 0.0 | 0.225 | 9.5 | LOS A | 1.4 | 9.7 | 0.46 | 0.59 | 52.8 |
| Approach | | 243 | 0.0 | 0.225 | 6.9 | LOS A | 1.4 | 9.7 | 0.46 | 0.59 | 53.0 |
| North: Clifton St | | | | | | | | | | | |
| 7 | L2 | 53 | 0.0 | 0.203 | 5.0 | LOS A | 1.1 | 8.0 | 0.26 | 0.61 | 51.6 |
| 9 | R2 | 211 | 0.0 | 0.203 | 8.6 | LOS A | 1.1 | 8.0 | 0.26 | 0.61 | 52.2 |
| Approach | | 263 | 0.0 | 0.203 | 7.9 | LOS A | 1.1 | 8.0 | 0.26 | 0.61 | 52.1 |
| West: Orlando St | | | | | | | | | | | |
| 10 | L2 | 158 | 0.0 | 0.181 | 4.8 | LOS A | 1.1 | 7.5 | 0.20 | 0.49 | 53.7 |
| 11 | T1 | 90 | 0.0 | 0.181 | 5.0 | LOS A | 1.1 | 7.5 | 0.20 | 0.49 | 54.8 |
| Approach | | 248 | 0.0 | 0.181 | 4.9 | LOS A | 1.1 | 7.5 | 0.20 | 0.49 | 54.1 |
| All Vehicles | | 754 | 0.0 | 0.225 | 6.6 | LOS A | 1.4 | 9.7 | 0.31 | 0.56 | 53.0 |

Level of Service (LOS) Method: Delay (HCM 2000).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.


Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY

 Site: Orlando St / Clifton St

New Site
Roundabout

Lane Use and Performance

| | Demand Flows | | Cap veh/h | Deg. Satn v/c | Lane Util % | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Config | Lane Length m | Cap. Adj % | Prob. Block. % |
|---------------------|----------------|---------|--------------|------------------|----------------|-------------------------|---------------------|-------------------|-----------|----------------|---------------------|---------------|-------------------|
| | Total veh/h | HV % | | | | | | Veh | Dist m | | | | |
| East: Orlando St | | | | | | | | | | | | | |
| Lane 1 _a | 243 | 0.0 | 1079 | 0.225 | 100 | 6.9 | LOS A | 1.4 | 9.7 | Full | 500 | 0.0 | 0.0 |
| Approach | | 243 | 0.0 | 0.225 | | 6.9 | LOS A | 1.4 | 9.7 | | | | |
| North: Clifton St | | | | | | | | | | | | | |
| Lane 1 _a | 263 | 0.0 | 1296 | 0.203 | 100 | 7.9 | LOS A | 1.1 | 8.0 | Full | 500 | 0.0 | 0.0 |
| Approach | | 263 | 0.0 | 0.203 | | 7.9 | LOS A | 1.1 | 8.0 | | | | |
| West: Orlando St | | | | | | | | | | | | | |
| Lane 1 _a | 248 | 0.0 | 1373 | 0.181 | 100 | 4.9 | LOS A | 1.1 | 7.5 | Full | 500 | 0.0 | 0.0 |
| Approach | | 248 | 0.0 | 0.181 | | 4.9 | LOS A | 1.1 | 7.5 | | | | |
| Intersection | | 754 | 0.0 | 0.225 | | 6.6 | LOS A | 1.4 | 9.7 | | | | |

Level of Service (LOS) Method: Delay (HCM 2000)

Roundabout LOS Method: Same as Signalised Intersections.

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes

Roundabout Capacity Model: SIDRA Standard

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Annexure E

SIDRA Results - Albany Hwy / Church Str

Albany Highway / Church Street - Existing

LANE LEVEL OF SERVICE

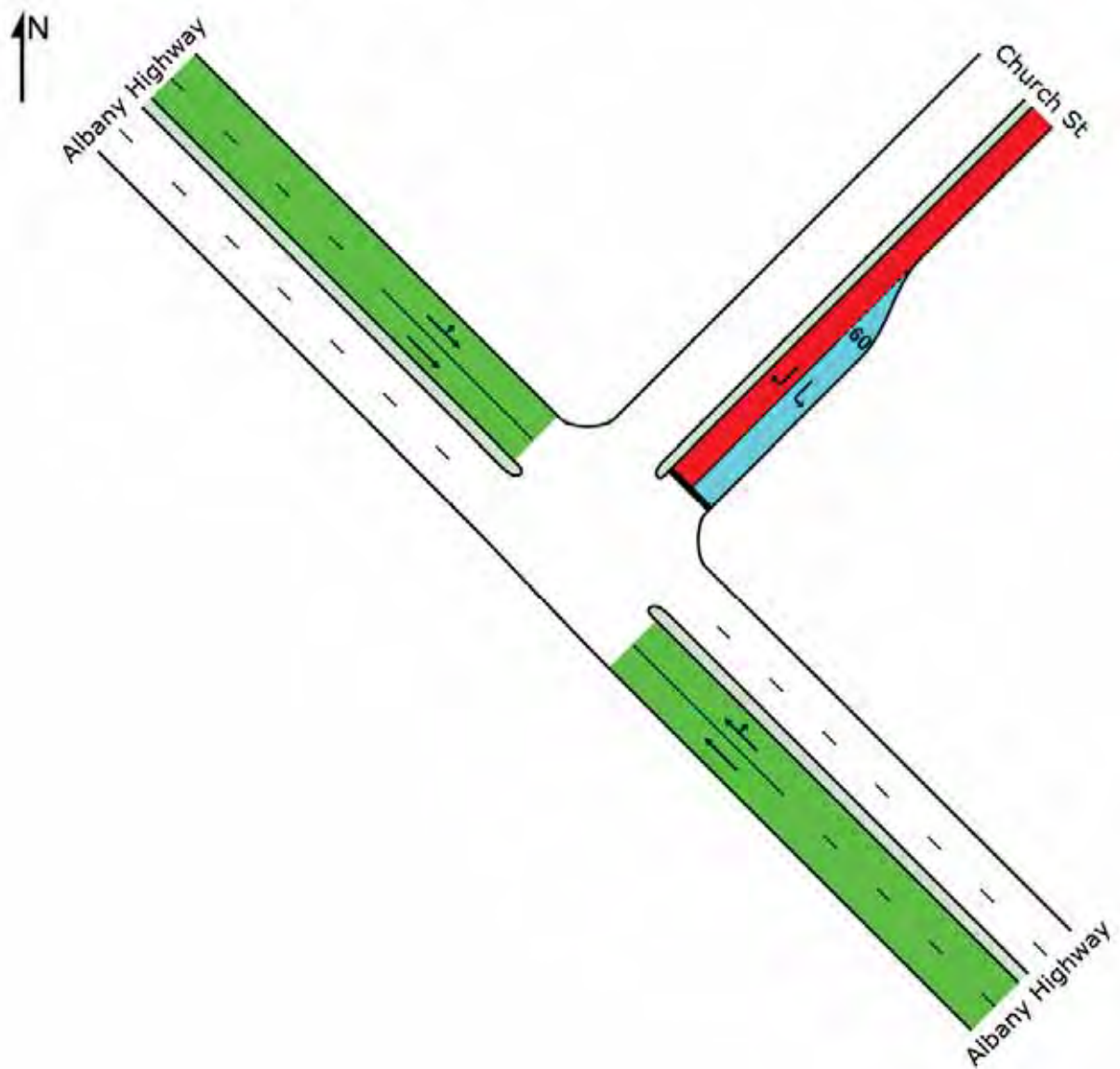
Lane Level of Service

 Site: 101 [Albany Highway / Church St - Existing AM]

New Site
Stop (Two-Way)


All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----|-----------|-----------|-----------|--------------|
| LOS | NA | F | NA | NA |



DELAY (CONTROL)

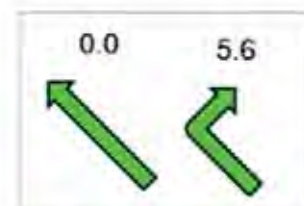
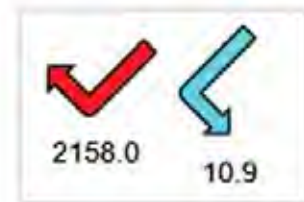
Average control delay per vehicle, or average pedestrian delay (seconds)

 Site: 101 [Albany Highway / Church St - Existing AM]

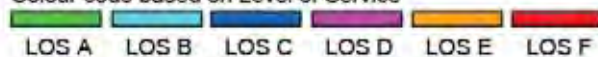
New Site
Stop (Two-Way)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----------------|-----------|-----------|-----------|--------------|
| Delay (Control) | 0.2 | 1221.7 | 0.2 | 80.2 |
| LOS | NA | F | NA | NA |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

LOS F will result if $v/c > 1$ irrespective of movement delay value (does not apply for approaches and intersection). SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

LANE LEVEL OF SERVICE

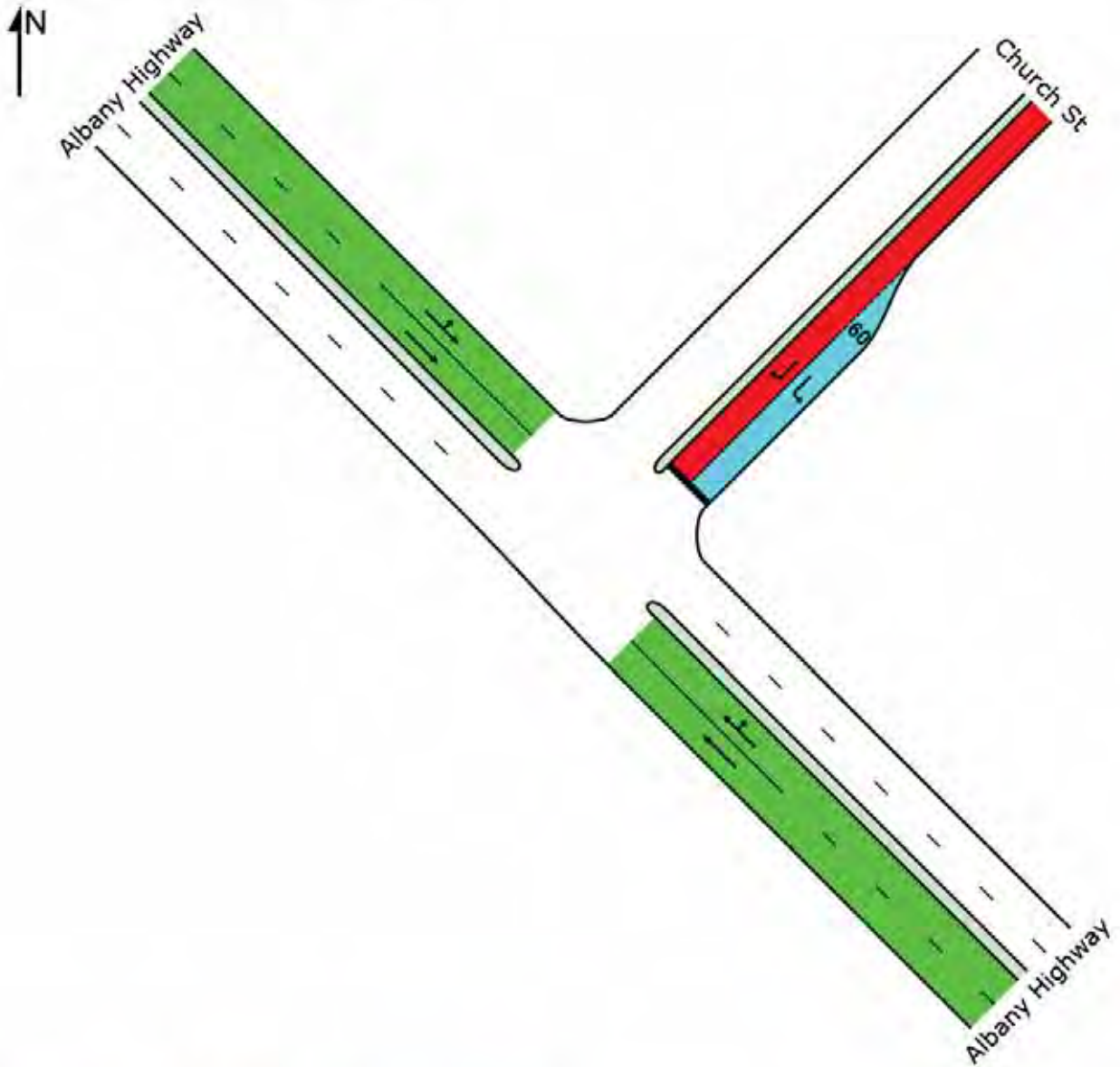
Lane Level of Service

STOP Site: 101 [Albany Highway / Church St - Existing PM]

New Site
Stop (Two-Way)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----|-----------|-----------|-----------|--------------|
| LOS | NA | F | NA | NA |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

LOS F will result if $v/c > 1$ irrespective of movement delay value (does not apply for approaches and intersection).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

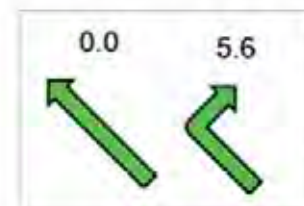
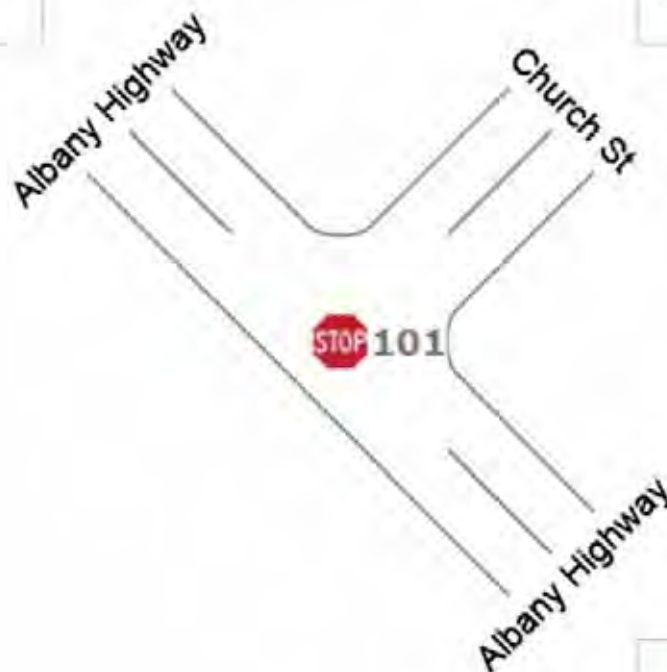
Average control delay per vehicle, or average pedestrian delay (seconds)

STOP Site: 101 [Albany Highway / Church St - Existing PM]

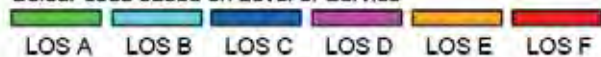
New Site
Stop (Two-Way)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----------------|-----------|-----------|-----------|--------------|
| Delay (Control) | 0.2 | 1723.1 | 0.2 | 40.6 |
| LOS | NA | F | NA | NA |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

LOS F will result if v/c > 1 Irrespective of movement delay value (does not apply for approaches and intersection).

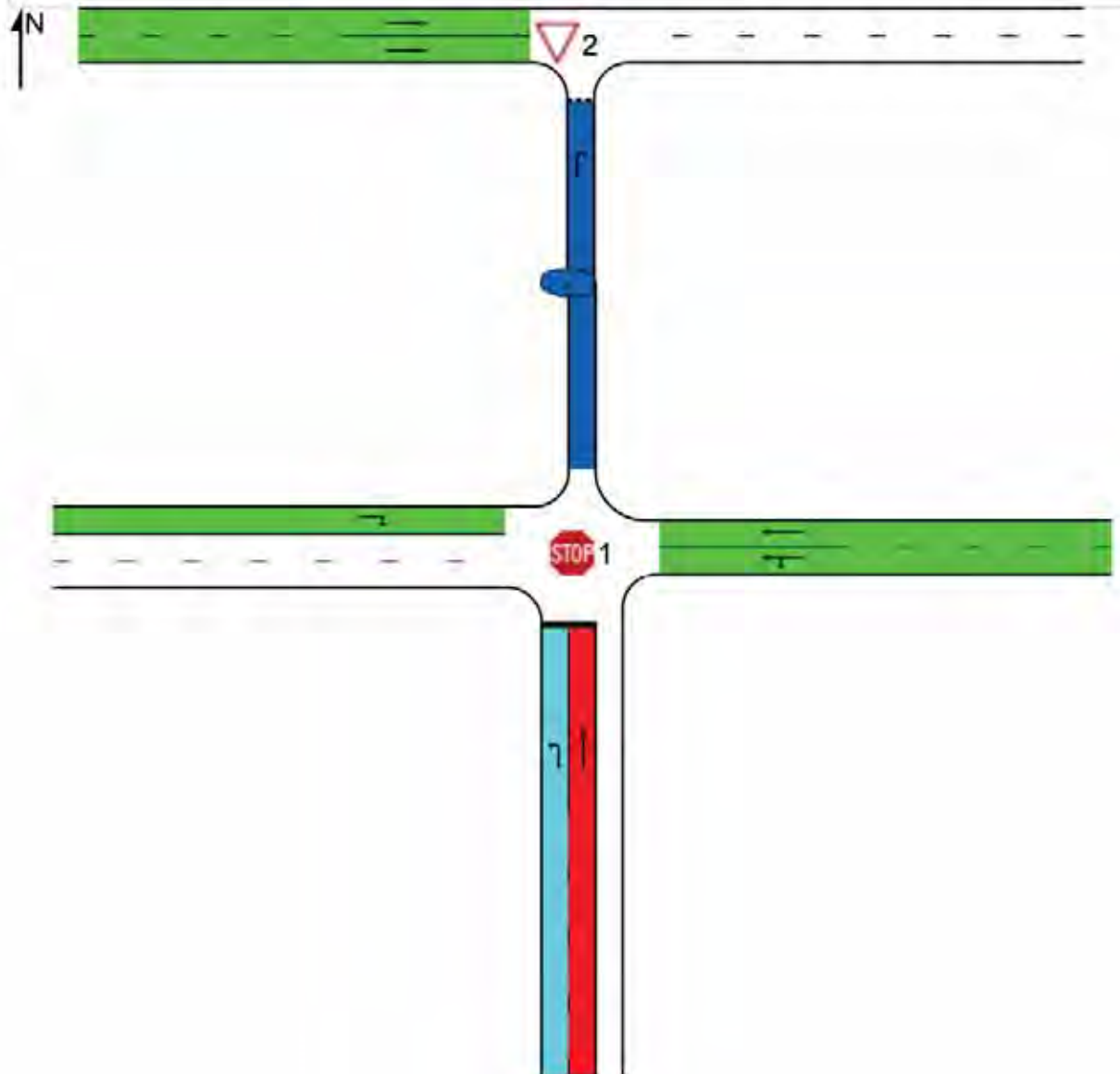
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

LANE LEVEL OF SERVICE

Lane Level of Service for Network Sites

Network: N101 [Network1]

New Network



Colour code based on Level of Service



LOS A LOS B LOS C LOS D LOS E LOS F TWSC Major Rd (HCM LOS Rule)

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

Delay model settings are specified for individual Sites forming the Network.

DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

Network: N101 [Network1]

Site: 2 [Stop 3-way Stage 2 (Median) L]

Staged crossing Stage 2 (Median) at three-way intersection with 5-lane major road.

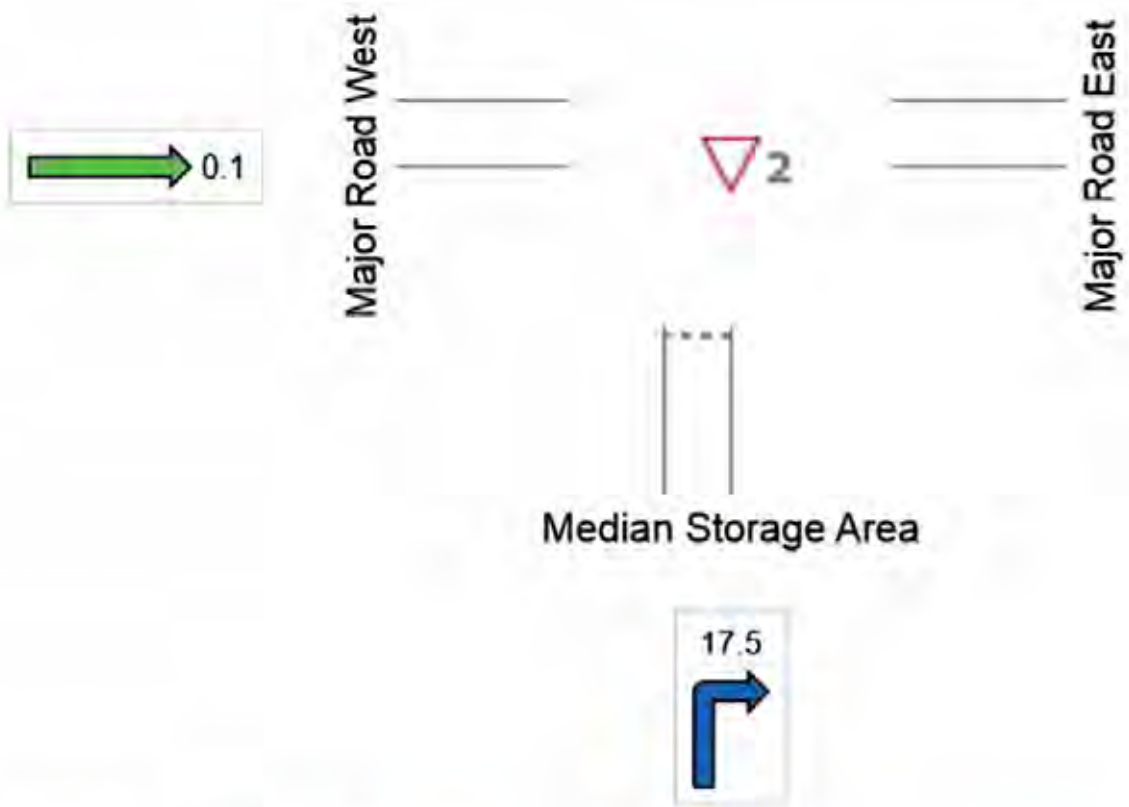
Give-way behaviour assumed at Stage 2.

Giveaway / Yield (Two-Way)

All Movement Classes

South West Intersection

| | | | |
|-----------------|------|-----|-----|
| Delay (Control) | 17.5 | 0.1 | 0.6 |
| LOS | C | NA | NA |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

Average control delay per vehicle, or average pedestrian delay (seconds)

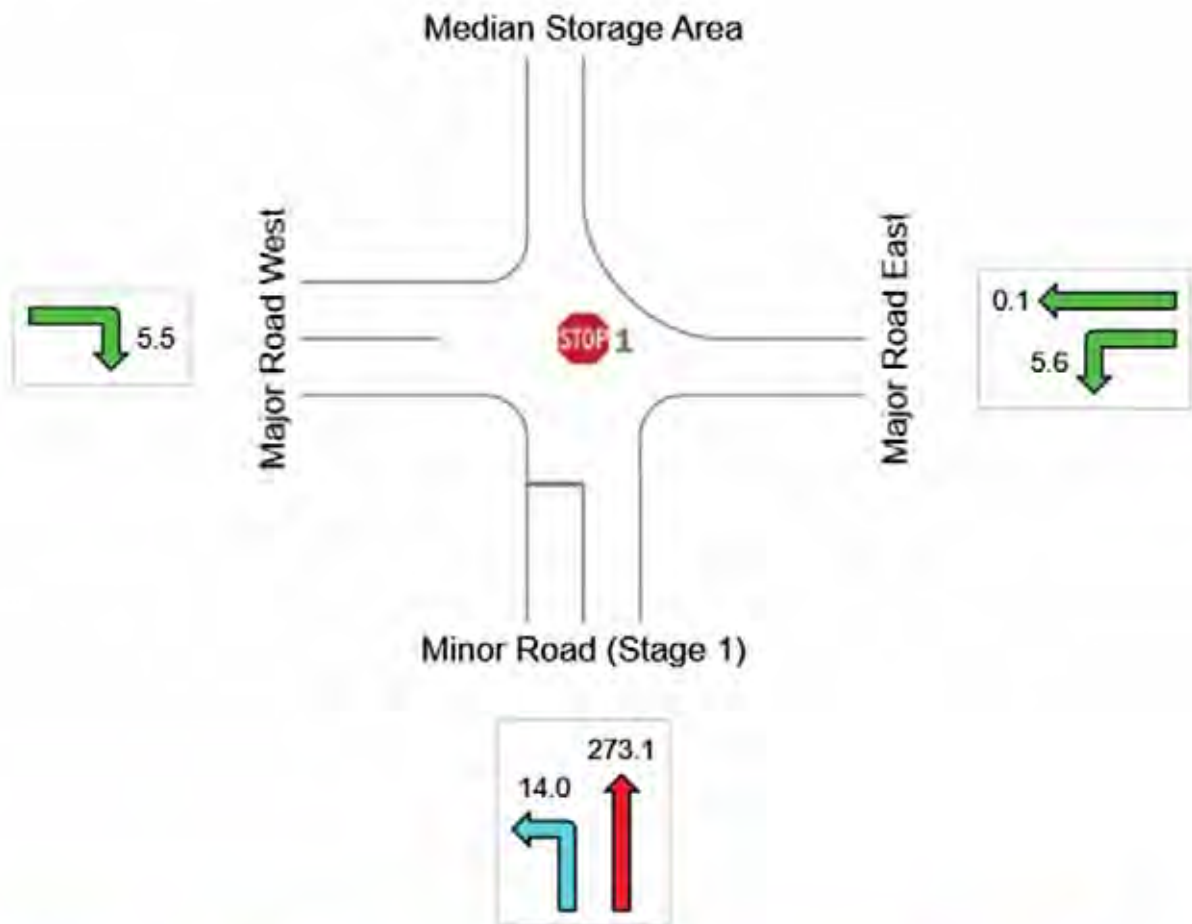
Network: N101 [Network1]

Site: 1 [Stop 3-way Stage 1 (Minor Road) L]

Staged crossing Stage 1 (Minor Road) at three-way intersection with 5-lane major road. Major road turn lane is treated as a full-length lane.
Stop (Two-Way)

All Movement Classes

| | South | East | West | Intersection |
|-----------------|-------|------|------|--------------|
| Delay (Control) | 143.6 | 0.3 | 5.5 | 9.1 |
| LOS | F | NA | NA | NA |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Network tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Albany Highway / Church Street Signalised Intersection

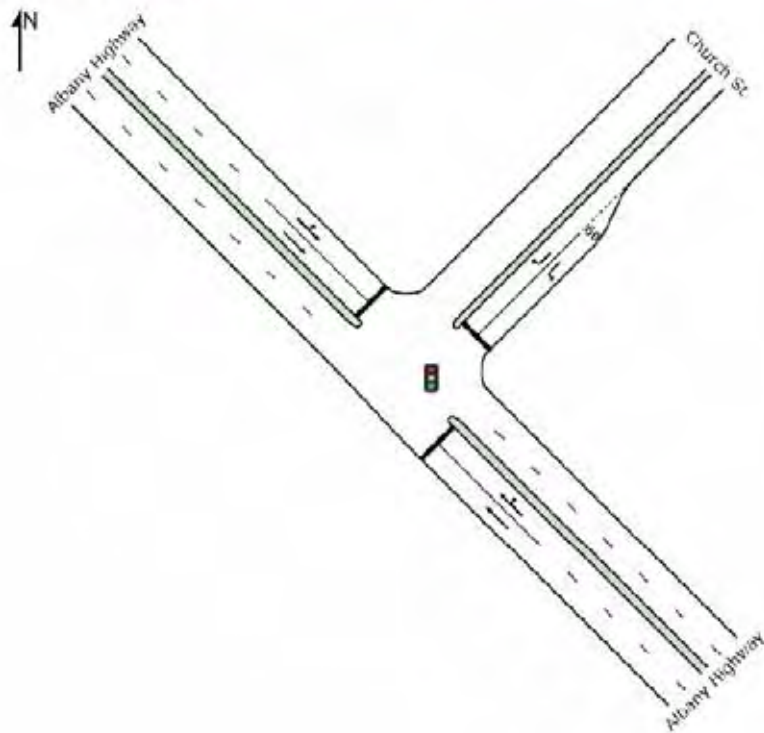


SITE LAYOUT

Site: 101v [Albany Highway / Church St - Import - Conversion]

New Site

Signal - Fixed time isolated



LANE LEVEL OF SERVICE

Lane Level of Service

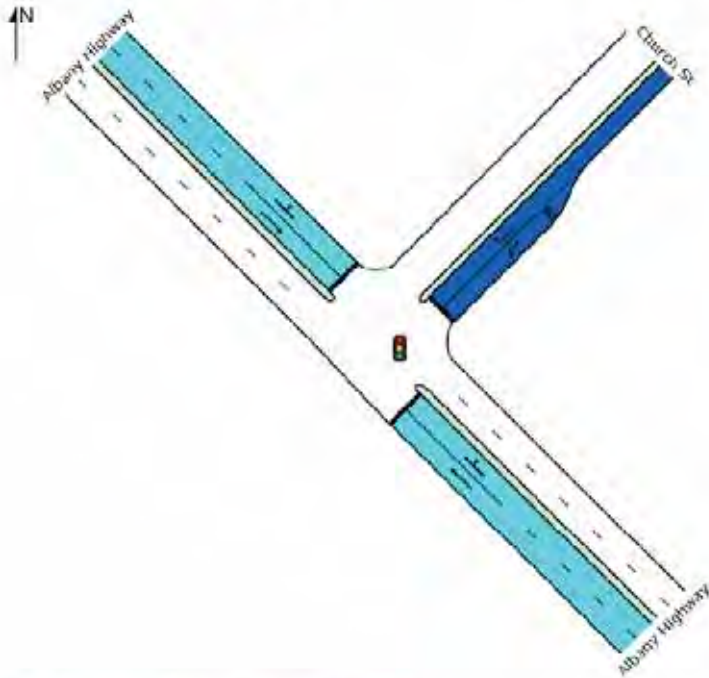
Site: 101v [Albany Highway / Church St - Import - Conversion]

New Site

Signals - Fixed Time Isolated - Cycle Time = 47 seconds (Practical Cycle Time)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|-----|-----------|-----------|-----------|--------------|
| LOS | B | C | B | B |



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab). SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (V/C ratio)

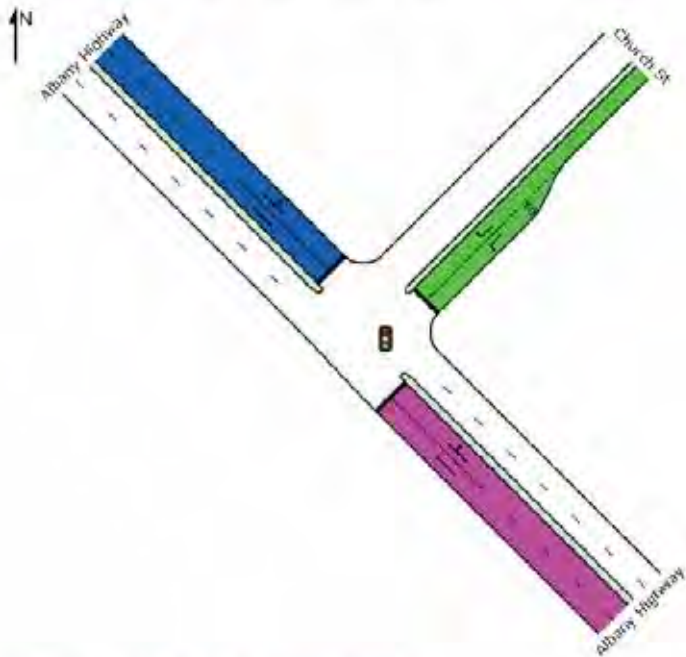
Site: 101v [Albany Highway / Church St - Import - Conversion]

New Site

Signals - Fixed Time Isolated - Cycle Time = 46 seconds (Practical Cycle Time)

All Movement Classes

| | Southeast | Northeast | Northwest | Intersection |
|----------------------|-----------|-----------|-----------|--------------|
| Degree of Saturation | 0.36 | 0.21 | 0.27 | 0.86 |



Colour code based on Degree of Saturation



MOVEMENT SUMMARY

Site: 101v [Albany Highway / Church St - Import - Conversion]

New Site

Signals - Fixed Time Isolated Cycle Time = 40 seconds (Practical Cycle Time)

Movement Performance - Vehicles

| Mov ID | OD Mov | Demand Flows | | Deg. Satn v/c | Average Delay sec | Level of Service | 95% Back of Queue | | Prop. Queued | Effective Stop Rate per veh | Average Speed km/h |
|---------------------------|--------|----------------|---------|------------------|----------------------|------------------|-------------------|---------------|--------------|--------------------------------|-----------------------|
| | | Total veh/h | HV % | | | | Vehicles veh | Distance m | | | |
| SouthEast: Albany Highway | | | | | | | | | | | |
| 22 | T1 | 1585 | 0.0 | 0.859 | 17.0 | LOS B | 21.2 | 148.7 | 0.93 | 1.04 | 46.8 |
| 23 | R2 | 58 | 0.0 | 0.859 | 24.1 | LOS C | 16.9 | 118.2 | 0.95 | 1.07 | 45.0 |
| Approach | | 1643 | 0.0 | 0.859 | 17.3 | LOS B | 21.2 | 148.7 | 0.93 | 1.04 | 46.7 |
| NorthEast: Church St | | | | | | | | | | | |
| 24 | L2 | 58 | 0.0 | 0.211 | 22.9 | LOS C | 1.1 | 7.5 | 0.91 | 0.73 | 42.8 |
| 26 | R2 | 58 | 0.0 | 0.211 | 22.9 | LOS C | 1.1 | 7.5 | 0.91 | 0.73 | 43.0 |
| Approach | | 116 | 0.0 | 0.211 | 22.9 | LOS C | 1.1 | 7.5 | 0.91 | 0.73 | 42.9 |
| NorthWest: Albany Highway | | | | | | | | | | | |
| 27 | L2 | 58 | 0.0 | 0.772 | 15.8 | LOS B | 15.0 | 104.8 | 0.84 | 0.84 | 49.9 |
| 28 | T1 | 1600 | 0.0 | 0.772 | 10.3 | LOS B | 15.0 | 104.8 | 0.84 | 0.84 | 51.2 |
| Approach | | 1658 | 0.0 | 0.772 | 10.5 | LOS B | 15.0 | 104.8 | 0.84 | 0.84 | 51.1 |
| All Vehicles | | 3417 | 0.0 | 0.859 | 14.2 | LOS B | 21.2 | 148.7 | 0.89 | 0.93 | 48.6 |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

LANE SUMMARY Site: 101v [Albany Highway / Church St - Import - Conversion]

New Site

Signals - Fixed Time Isolated Cycle Time = 40 seconds (Practical Cycle Time)

Lane Use and Performance

| | Demand Flows | | Cap. veh/h | Deg. Satn v/c | Lane Util. % | Average Delay sec | Level of Service | 95% Back of Queue | | Lane Config | Lane Length m | Cap. Adj. % | Prob. Block. % |
|---------------------------|----------------|---------|---------------|------------------|-----------------|----------------------|------------------|-------------------|-----------|-------------|------------------|----------------|-------------------|
| | Total veh/h | HV % | | | | | | Veh | Dist m | | | | |
| SouthEast: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 935 | 0.0 | 1089 | 0.859 | 100 | 16.0 | LOS B | 21.2 | 148.7 | Full | 500 | 0.0 | 0.0 |
| Lane 2 | 707 | 0.0 | 824 | 0.859 | 100 | 19.0 | LOS B | 16.9 | 118.2 | Full | 500 | 0.0 | 0.0 |
| Approach | | 1643 | 0.0 | 0.859 | | 17.3 | LOS B | 21.2 | 148.7 | | | | |
| NorthEast: Church St | | | | | | | | | | | | | |
| Lane 1 | 58 | 0.0 | 274 | 0.211 | 100 | 22.9 | LOS C | 1.1 | 7.5 | Short | 60 | 0.0 | NA |
| Lane 2 | 58 | 0.0 | 274 | 0.211 | 100 | 22.9 | LOS C | 1.1 | 7.5 | Full | 500 | 0.0 | 0.0 |
| Approach | | 116 | 0.0 | 0.211 | | 22.9 | LOS C | 1.1 | 7.5 | | | | |
| NorthWest: Albany Highway | | | | | | | | | | | | | |
| Lane 1 | 843 | 0.0 | 1091 | 0.772 | 100 | 10.6 | LOS B | 15.0 | 104.8 | Full | 500 | 0.0 | 0.0 |
| Lane 2 | 815 | 0.0 | 1056 | 0.772 | 100 | 10.4 | LOS B | 14.6 | 102.1 | Full | 500 | 0.0 | 0.0 |
| Approach | | 1658 | 0.0 | 0.772 | | 10.5 | LOS B | 15.0 | 104.8 | | | | |
| Intersection | | 3417 | 0.0 | 0.859 | | 14.2 | LOS B | 21.2 | 148.7 | | | | |

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Annexure F

Footpath Network Plan






Annexure G

Potential Evacuation Routes Plan



LEGEND

-  Clifton St South LSP Area
-  Key Roads
-  Existing Bridges & River/Creek Crossings

POTENTIAL EVACUATION ROUTES PLAN
 Clifton St South Precinct
 KELMSCOTT

| | | | | |
|----------|------------|------------------|------|----------|
| Plan No. | 2016-114 | KELMSCOTT OFFICE | DATE | 19/02/16 |
| Date | 19/02/16 | Author | MAK | |
| Drawn | MAK | Checked | JC | |
| Revised | A | Approved | A | |
| Scale | 1:20000000 | | | |

APPENDIX E

Servicing Report Shawmac

Minor modifications to the LSP layout were required by the WAPC which are inconsequential to the content of the Servicing Report.



CONSULTING CIVIL & TRAFFIC ENGINEERS, RISK MANAGERS.



Project: Local Structure Plan – Clifton Street South Precinct,
Kelmscott
Servicing Report

Client: Harley Dykstra





Job Number: 1410010

Author: James Bridge

Date: 21-10-15

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Document Status

| Version No | Author | Reviewed by | Date | Document status | Signature | Date |
|------------|--------------|--------------|----------|------------------|---|----------|
| A | James Bridge | Ryan Needham | 17/12/14 | Internal Review |  | 17/12/14 |
| B | James Bridge | Ryan Needham | 19/12/14 | Client Review |  | 19/12/14 |
| C | James Bridge | Ryan Needham | 12-01-15 | LSP Submission |  | 13-01-15 |
| D | James Bridge | Ryan Needham | 21-10-15 | Minor Amendments |  | 21-10-15 |
| | | | | | | |
| | | | | | | |

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1. Purpose

The purpose of this report is to detail existing infrastructure within the immediate area of the proposed development and identify any deficiencies, necessary improvements/upgrades to existing or new services and to identify whether there are any constraints to development with respect to the required serving infrastructure.

2. Background

Shawmac was commissioned by Harley Dykstra to prepare a preliminary servicing report associated with the proposed subdivision of Lots 20-26 Clifton Street, Kelmscott.

To determine requirements and the feasibility for serving the proposed development sites, the respective stakeholders/authorities were contacted to advise what requirements/upgrades would be required.

3. Site Location

The Local Structure Plan (LSP) area is located adjacent to Clifton Street in Kelmscott.

The site is proposed to be developed for a mixture of single, grouped and multiple dwellings, ranging in density from R40 to R80. A total of 386 dwellings may be provided with the development of the subject site.

The existing land use is classified as "Urban Development Zone" as per City of Armadale's Town Planning Scheme No. 4.



Figure 1 – Proposed Development Area

4. Services Assessment

4.1 Water Reticulation

Since the original submission to Water Corporation the amount of proposed dwellings has increased from 375 to 386. This is only a minor increase and therefore Water Corporation's servicing assessment is still deemed applicable.

Currently there is a 205mm steel pipe and 100mm cast iron pipe running along Gilwell Avenue as well as a 400mm steel pipe and a 100mm cast iron pipe running along Lucich Street and then south along Clifton Street.

Water Corporation have confirmed that servicing can be achieved by connection to the existing network (refer Appendix A).

4.2 Sewer

Since the original submission to Water Corporation the amount of proposed dwellings has increased from 375 to 386. This is only a minor increase and therefore Water Corporation's servicing assessment is still deemed applicable.

There are no existing sewer services in close proximity of the proposed development site with the exception of a privately owned sewer pump station at the Aged Care Hostel on Lot 22 which pumps sewerage up Lucich Street through a 50mm PVC pipe.

The Water Corporation have confirmed that the sewer network will need to gravitate to an existing pump station (Pump Station No.4) at the end of River Road (refer Appendix A). This will require the sewer infrastructure to cross the Canning River.

As per Figure 2 overleaf, there is also a future proposed gravity sewer starting from behind existing Lot 525 (near Lucich and Charles Street intersection) which will run down between Lots 23 and 24 and across the Canning River to Pump Station No.4 on River Road. It is not yet known if/when this sewer line will be installed.

If this identified future proposed sewer line has not been installed at the time of commencement of development of the LSP area, then a connection will need to be provided across the Canning River and into Pump Station 4 at River Road. If the future proposed sewer line has already been installed, then the sewer for the LSP area may be able to connect into the existing infrastructure (if approved by Water Corporation) and therefore will not require an additional crossing over the river and into the pump station. If this is the case, the already installed sewer may require relocation within the proposed road reserve to ensure it does not clash with the proposed basins and stormwater. Specific sewer requirements will be confirmed at the subdivision stage, based on the extent of infrastructure in place at that time and the staging of development.

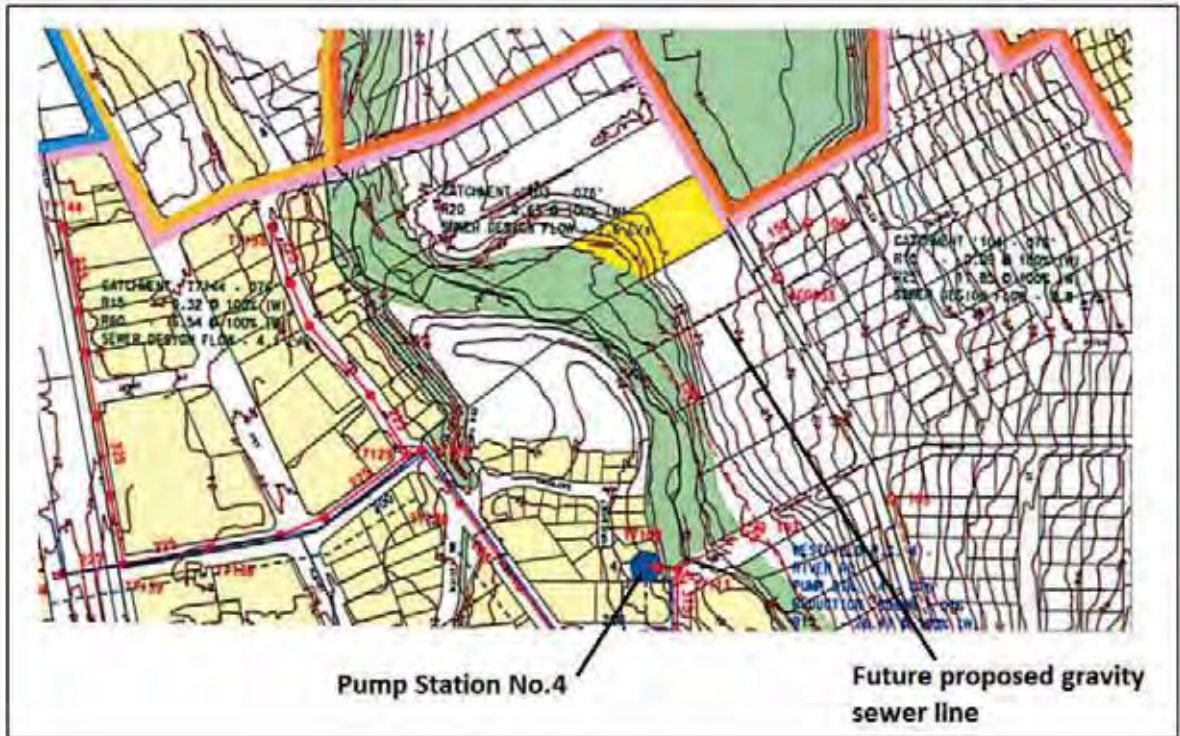


Figure 2 – Existing Sewer Network

4.3 Power

Since the original submission to Western Power the amount of proposed dwellings has increased from 375 to 386. This is only a minor increase and therefore Western Power's servicing assessment is still deemed applicable. Western Power have confirmed that there is a 22kV network (G522 85 Wheatley St feeder) running along Clifton St (refer Appendix B). The load generated by the development can be connected to this feeder using 185mm² or 400mm² Al XLPE 22kV cables.

Unless the available spare capacity on the G522 feeder are allocated or used up by other customers prior to development within the LSP area applying for connection, it is likely that no reinforcement works on the existing network are required for this connection.



Figure 3 – Existing Power Network

There are also overhead power lines running along Clifton Street on the western side. If any of the proposed intersections clash with the existing power poles the power will need to be converted to underground power under the road intersection.

4.4 Medium Pressure Gas Main

Since the original submission to Atco the amount of proposed dwellings has increased from 375 to 386. This is only a minor increase and therefore Atco's servicing assessment is still deemed applicable.

A medium pressure gas main runs along the western side of Clifton Street. As advised by Atco, the medium pressure gas main has the capability of serving an additional 2000 dwellings which is sufficient for the proposed development (refer Appendix C). As the site can be serviced from the medium pressure line, there would be no pressure reduction infrastructure required to bring gas to the new development.

4.5 High Pressure Gas Main

A high pressure gas main runs along the eastern side of Clifton Street. Atco will need to be contacted for approval of any site works within 15m of this service prior to construction. This will include intersection civil works and any service connections along Clifton Street.

4.6 Telecommunications

The NBN has not been rolled out in the area and there is no timeframe for installation of NBN services in the area however NBN will install new cable in developer provided pit and pipe where >100 lots are proposed. If NBN are unable to install the NBN infrastructure then Telstra will provide the service.

In the interim, before connection to NBN, the existing telecommunications infrastructure running along Clifton Street is capable of servicing the LSP area.

4.7 Water Bores

There are two bores located within Lot 20 and 21. The City of Armadale have confirmed that both bores supply two thirds of the demand for Frye Park.



Figure 4 – Existing Bore Locations

The existing headworks, power supply, controller and bore monitoring services located adjacent to Clifton Street proposed to be retained within public open space. Therefore no additional works are required as the services will not be impacted.

The headworks, controller and bore monitoring located at the northwest open space, adjacent to the Canning River, either falls outside of the LSP boundary or within proposed public open space. These services will need to be surveyed to ensure the shared path, basins and outlet stormwater pipes do not impact these services. The City of Armadale has also confirmed that this service is powered by an underground power cable from the Clifton Street bore. The underground cable and the water pipe running to Frye Park will need to be surveyed and will most likely need to be relocated into a new road reserve.

4.8 Existing Stormwater

There are existing stormwater pipes running along Clifton Street, with part of the system running between Lot 22 and 23 down to the Canning River, as shown in Figure 5. The City of Armadale have confirmed that the existing drainage system cannot be used to capture the 1 and 5 year storm events.

New development fronting Clifton Street (to the south of Lucich Street) will need to be raised from the natural surface level to tie in to Clifton Street. As a result, the 1 year event for these lots could be treated through soakwells on site. The 5 year storm event will then flow into the proposed drainage system at the back of the Lots within a drainage easement. The 100 year storm event will flow onto Clifton Street and into the proposed development along the new roads and is directed towards the proposed basins.



Figure 5 – Existing Stormwater Infrastructure

4.9 Bulk Earthworks

With the current survey, the contours show the land falling down towards Canning River at approximately 0.5% to 1% before steepening closer to the river. The new development sites will step down with the terrain towards the river – either with the use of retaining walls or with the level change accommodated within the new built form. The western end of Lot 22 adjacent to the Canning River will require retaining walls over 1m high to reduce lot grades and to ensure the lot is above the food fringe.

There has been no detailed geotechnical investigations undertaken to date, however, findings from water bore logs show the site consists of predominantly loam and silty clay. As a result, it is expected that the new development sites will need to be raised above the existing surface and/or the foundation material replaced with suitable material.

The Perth Groundwater Atlas shows groundwater at around 17-18m which ranges approximately 4-13m below the existing surface levels of the subject land. Therefore groundwater is not an issue in regards to basin and new development site levels.

There is also approximately 0.5 to 1m drop adjacent to Clifton Street before the natural terrain falls at 0.5% to 1% towards the river. As a result, the proposed lots that are to front Clifton Street will need to be raised to allow sufficient lot grades and tie in to Clifton Street. Lots will need to be raised with retaining structures with some sections of retaining walls over 1m high.

5. Staging of Works

5.1 General

If the LSP area is developed in different stages, due consideration will need to be given to servicing alignments and depths and earthwork levels to ensure that all subsequent development can occur in an efficient and coordinated manner.

5.2 Drainage

The first area to be developed within a catchment area will be responsible for constructing the proposed basin within that catchment area.

Drainage pipe sizes and levels will need to be installed for each staged development to allow connection by all the other lots that could be developed in the future that require directing stormwater to the same basin.

5.3 Sewer

The first lot to be developed within the development area will be responsible for constructing a sewer connection to the Pump Station No. 4 at River Road via a pre-funding agreement with Water Corporation. This will include a crossing under the Canning River.

Sewer pipe sizes and levels will need to be installed for each staged development to allow connection of all the other lots that could be developed in the future to allow sewerage to be gravity fed to the existing Pump Station No. 4 at River Road.

6. Conclusion

The report confirms the following key points:

- There is adequate water reticulation services in the area to service the proposed development;
 - A gravity sewer line will need to direct sewerage to the existing pump station on River Road;
 - There is adequate power services in the area to service the lots;
 - There is adequate gas services in the area to service the lots through the medium pressure gas main. Works within 15m of the high pressure gas main will need to be approved by Atco prior to commencement;
 - NBN will service any individual development greater than 100 lots in size;
 - Power servicing the water bore closest to the Canning River and the water pipe supplying water from the bore to Frye Park will need to be located and most likely relocated as part of civil construction works;
- and

In summary, there are no constraints to the development of the subject land.

Appendix A Water Corporation Assessment

James Bridge

From: Frank Kroll <Frank.Kroll@watercorporation.com.au>
Sent: Thursday, 18 December 2014 11:29 AM
To: 'jbridge@shawmac.com.au'
Cc: Ross Crockett
Subject: Lots 20 to 26 Clifton Street Kelmscott - Servicing Feasibility
Attachments: 201412181056.pdf; 201412181102.pdf; 201412181102.pdf

File JT1 2006 12112 v01

Hi James

With reference to your enquiry dated 3 December 2014.

Attached are:-

Plans of existing water and sewer services (3) Plans of current wastewater scheme (2)

Water Supply:

Servicing can be achieved by connection to the existing network adjacent.

Wastewater:

Network to gravitate to the existing Pump Station No. 4 River Road.

Should you have any queries, please contact either myself or Mr Ross Crockett on 9420 2013.

Regards

Frank Kroll
Senior Development Planner
Development Services Branch

Water Corporation
Planning & Capability Group

629 Newcastle Street Leederville 6007
Telephone: (08)9420 2221
Fax: (08)9420 3193
Email: frank.kroll@watercorporation.com.au

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From: 25027@watercorporation.com.au [mailto:25027@watercorporation.com.au]
Sent: Thursday, 18 December 2014 10:57 AM
To: Frank Kroll
Subject: Message from "RNP00267349E7DC"

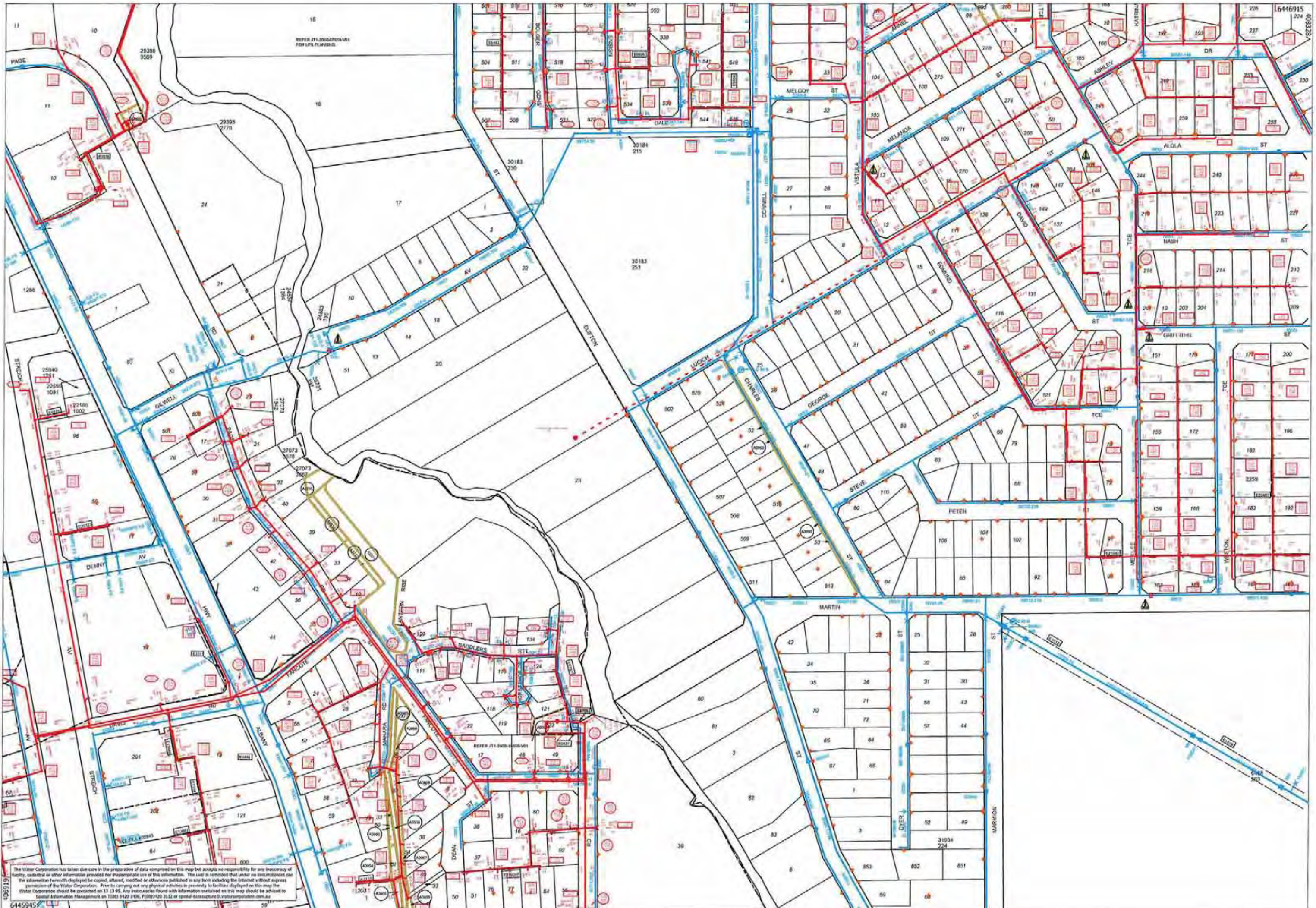
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Scan Date: 18.12.2014 10:56:38 (+0800)

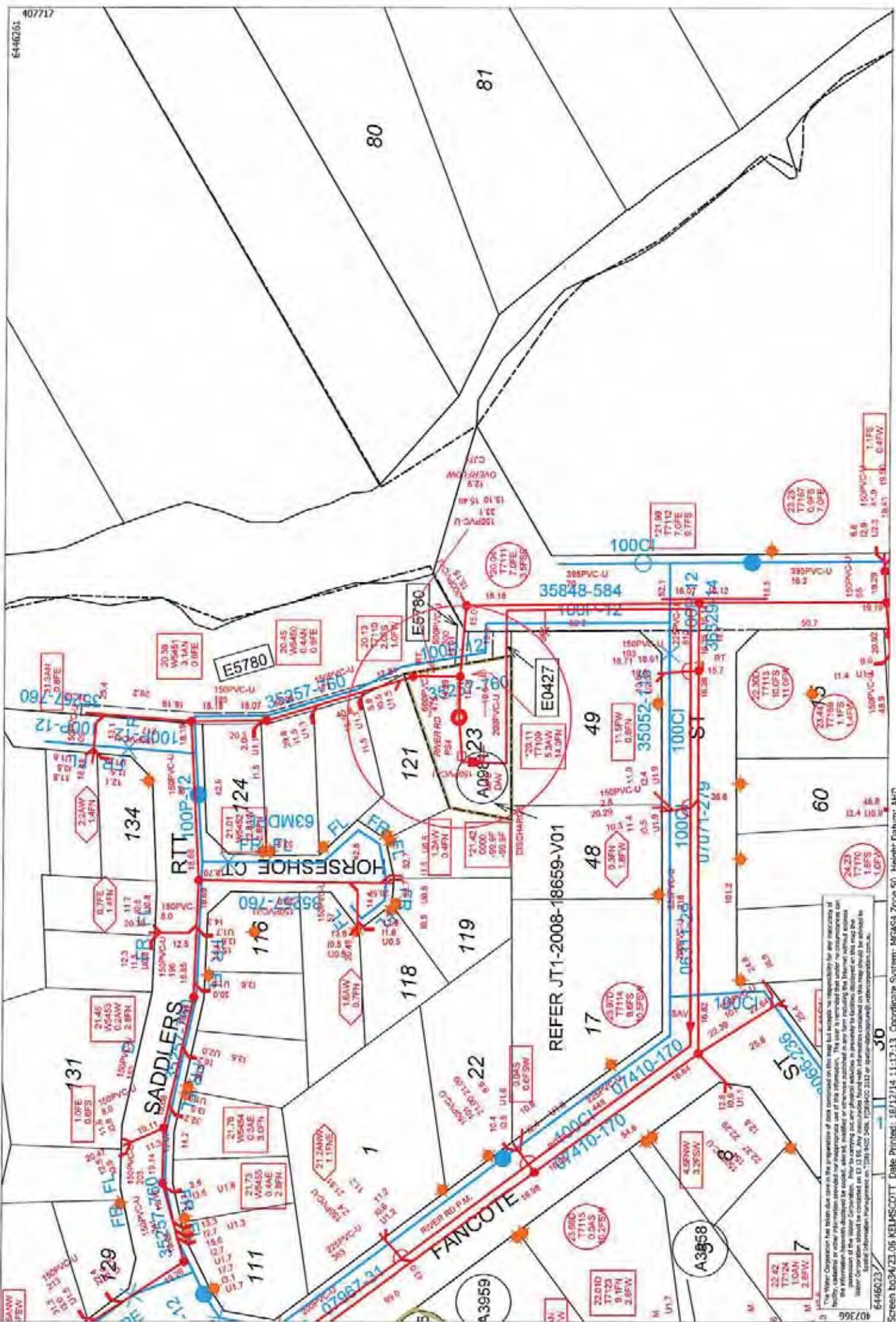
Queries to: 25027@watercorporation.com.au

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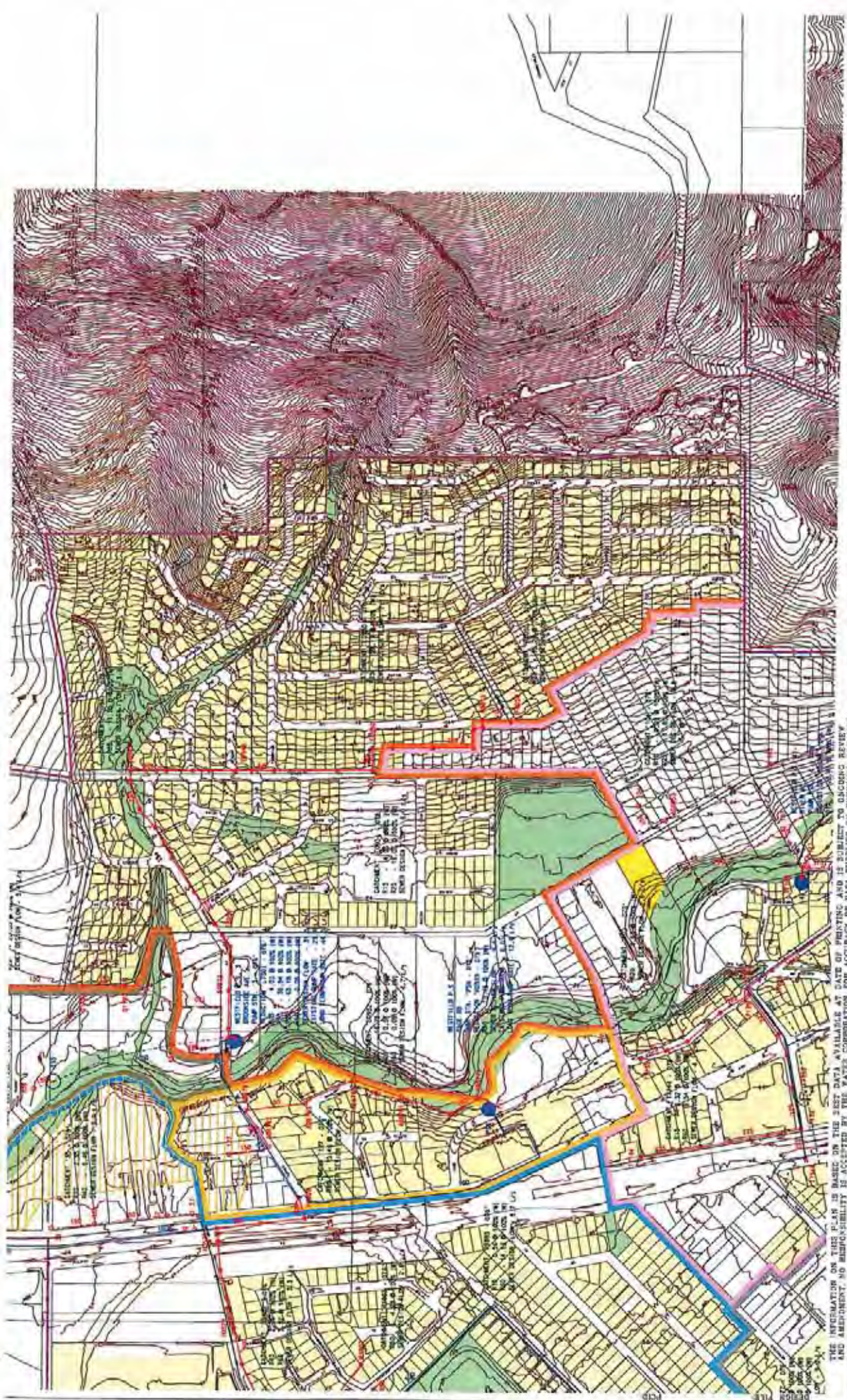


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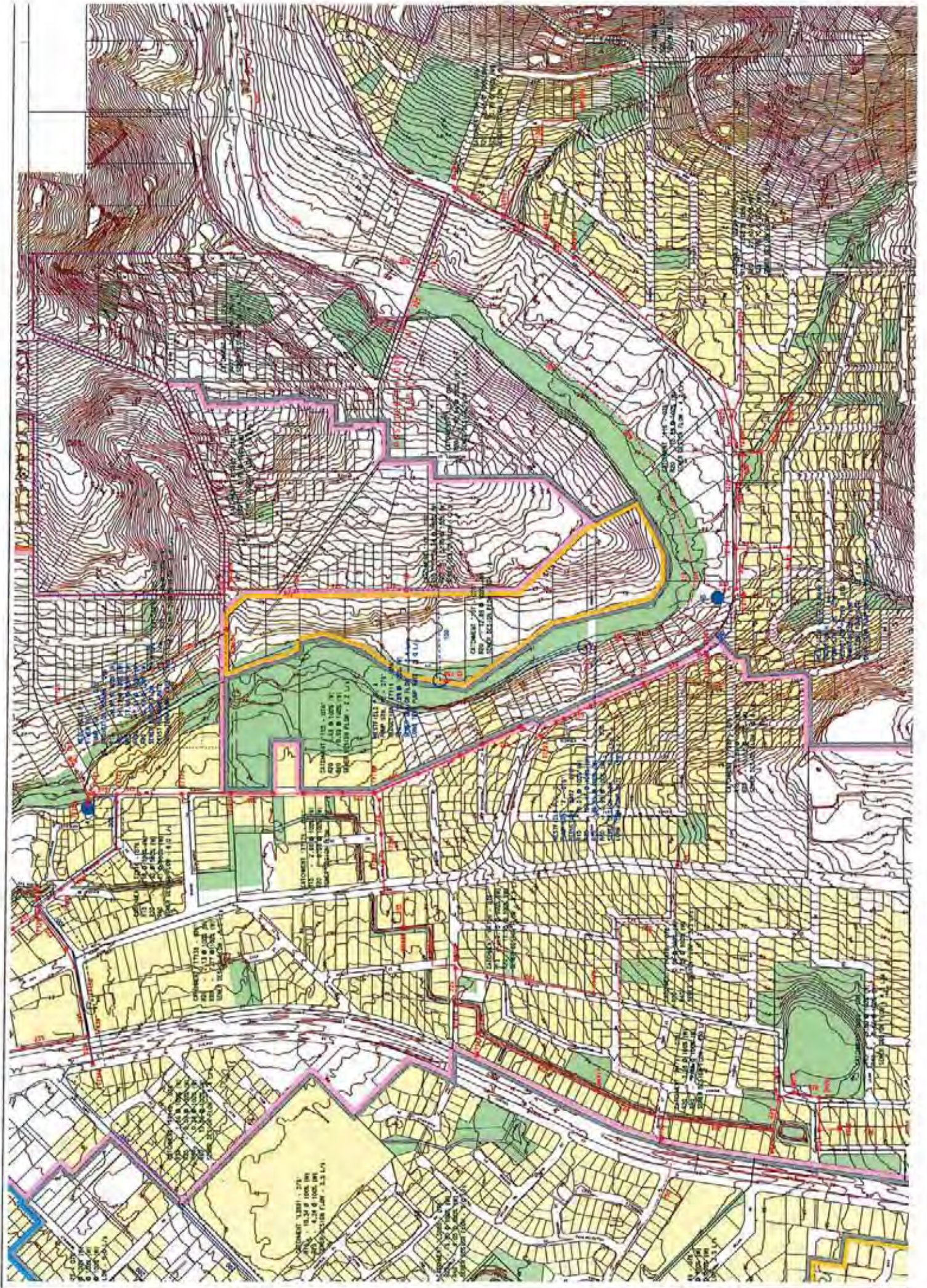
- PARKS AND PUBLIC OPEN SPACE
- EXISTING PUMPING STATION
- EXISTING SEWERED AREAS
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- SERVED BY PRIVATE PS
- NOSE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WITH CATCHMENT

NOTATION



SHEET INDEX





Appendix B Western Power Assessment



Feasibility Enquiry Report

Project: Clifton Street South, Kelmscott

Customer: Shawmac Pty Ltd

WP Reference: MF010179

Lot/Load: 375 Lots -Residential

Related Files:

Prepared By: Chinh Ngo (Work Scoping)
Brian Lee (Engineering and Design)

Feasibility Study

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| 1.3 Electrical Requirements..... | 4 |
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| 2.2 Study Model | 4 |
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| 3 Conclusion | 5 |
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| 3.2 Reinforcement Requirements | 5 |

1 Development Proposal

1.1 Location Details

The proposed subdivision load is located near the T-junction between Clifton St and Lucich St, Kelmscott. It is located approximately 8.5 km from Gosnells (G) Zone Substation, measured along the G522 feeder backbones. Figure 1 below shows the geographical location of the proposed subdivision load.

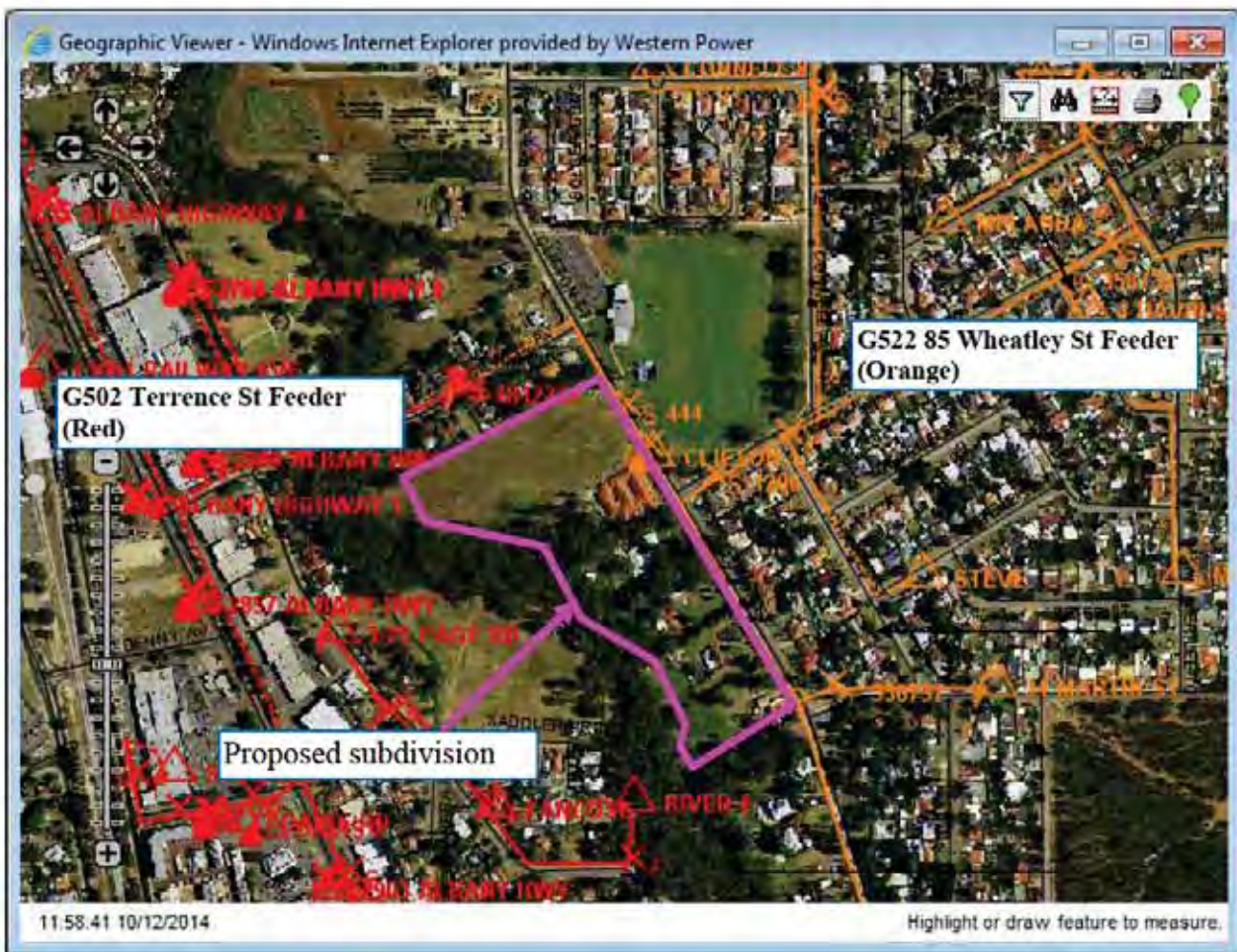


Figure 1 – Proposed Development area and surrounding distribution network

1.2 Development Details

| | |
|-------------------------|---------------|
| Number of lots: | 375 |
| Land Use: | Residential |
| Calculated Area: | NA |
| Staging: | not specified |

1.3 Electrical Requirements

Based on the nominal 4.7kVA per lots, the estimated design capacity of (375 x 4.7kVA) 1.762 MVA has been assumed.

2 Study

2.1 Electrical Connection

There are two HV feeders running in the vicinity of this subdivision, they are G502 and G522 feeders. Based on the last 12 months feeder load readings excluding abnormal load transfer, the G502 feeder has a peak load of around 240A and the G522 feeder has a peak load of around 120A.

2.2 Study Model

There is no PowerFactory model set up for this feasibility enquiry study. However, high level investigation indicated that there is some spare network capacity available in the vicinity to supply this subdivision.

2.3 Study Results

As the commencement date and staging for this subdivision is not specified in the feasibility application form, it is difficult to determine whether any network reinforcement are required to supply the entire 375 lots.

If the subdivision was to start today, it is likely that no network reinforcement would be required. However, the spare network capacity can be taken by other customers at any time.

3 Conclusion

3.1 Connection Requirements

There is 22kV network (G522 85 Wheatley St feeder) running along Clifton St of the subdivision boundary. The subdivision load can be connected to this feeder using 185mm² or 400mm² Al XLPE 22kV cables.

3.2 Reinforcement Requirements

Unless the available spare capacity on the G522 feeder are allocated or used up by other customers prior to this subdivision applied for connection, it is likely that no reinforcement works on the existing network are required for this connection

Please Note: Power systems are dynamic in nature, due to new users and frequent changes in consumer behaviour. As such, Western Power's distribution electricity networks will change over time - this may have a bearing on the amount of reinforcement required to accommodate new developments.

Applicants need to be aware that Western Power's response may become out-of-date, resulting in a significant variation in power infrastructure requirements. To provide a firm connection proposal and cost, a formal application to Western Power will need to be made, in accordance with current connection policies.

Appendix C Atco Assessment

James Bridge

From: Pemberton, Chris <Chris.Pemberton@atcogas.com.au>
Sent: Wednesday, 17 December 2014 10:05 AM
To: James Bridge
Subject: RE: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Hi James,

I just received confirmation. It is from the Medium Pressure network. This means that there would be no pressure reduction infrastructure required to bring gas to the new development.

Thanks,

Chris Pemberton
Business Development – Land Developers



www.atcogas.com.au



81 Prinsep Road, Jandakot, Western Australia, 6164
Mobile: 0429 270 124 | E-mail: chris.pemberton@atcogas.com.au

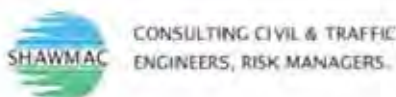
From: James Bridge [<mailto:jbridge@shawmac.com.au>]
Sent: Wednesday, 17 December 2014 9:24 AM
To: Pemberton, Chris
Cc: Lude, Nathan; Stubbs, Marc
Subject: RE: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Thanks Chris.

Let me know whether it will be from the HP or MP mains.

Regards,

James Bridge
Civil Engineer



T: (08) 9355 1300
F (08) 9355 1922
M: 0439 772 003
E: jbridge@shawmac.com.au

From: Pemberton, Chris [<mailto:Chris.Pemberton@atcogas.com.au>]
Sent: Wednesday, 17 December 2014 8:29 AM
To: James Bridge

Cc: Lude, Nathan; Stubbs, Marc

Subject: RE: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Hi James,

Our existing network along Clifton Street can supply to an additional 2,000 dwellings. I just need to confirm if this is from our High Pressure gas main, or Medium Pressure main, as we have both in Clifton St.

We have no planned upgrade works in the area.

Best regards,

Chris Pemberton

Business Development – Land Developers



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www.atcogas.com.au



81 Prinsep Road, Jandakot, Western Australia, 6164

Mobile: 0429 270 124 | E-mail: chris.pemberton@atcogas.com.au

From: James Bridge [<mailto:jbridge@shawmac.com.au>]

Sent: Tuesday, 16 December 2014 12:43 PM

To: Pemberton, Chris

Cc: Lude, Nathan; Stubbs, Marc

Subject: RE: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Hey Chris,

How is the below request progressing?

Regards,

James Bridge

Civil Engineer



CONSULTING CIVIL & TRAFFIC
ENGINEERS, RISK MANAGERS.

T: (08) 9355 1300

F (08) 9355 1922

M: 0439 772 003

E: jbridge@shawmac.com.au

From: Pemberton, Chris [<mailto:Chris.Pemberton@atcogas.com.au>]

Sent: Friday, 5 December 2014 7:40 AM

To: jbridge@shawmac.com.au

Subject: FW: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Good morning James,

Not sure if Nathan already responded to you....

Thanks for your e-mail. We will have a look and do some gas load modelling. Will get back to you hopefully next week.

Have a great weekend.

Best regards,

Chris Pemberton
Business Development – Land Developers



Connecting WA
to natural gas

www.atcogas.com.au



81 Prinsep Road, Jandakot, Western Australia, 6164
Mobile: 0429 270 124 | E-mail: chris.pemberton@atcogas.com.au

From: James Bridge [<mailto:jbridge@shawmac.com.au>]
Sent: Wednesday, 3 December 2014 4:49 PM
To: Lude, Nathan
Cc: Stubbs, Marc
Subject: Request for Feasibility Enquiry - Clifton Street (South) Kelmscott

Hi Nathan,

Shawmac has been commissioned to undertake an assessment of availability and suitability of services adjacent to the proposed development area located along Clifton Street in Kelmscott as shown on the attached drawing.

The development is expected to be predominately R40 and R60 with one R80.

Shawmac is seeking information from Atco in order to identify the implications of this development on infrastructure and service provisions.

Accordingly, it would be appreciated if Atco could provide information relevant to existing and planned services within the development area.

In particular, information sought includes:

- Existing services layout and extents
- Existing service capacities
- Plans for future upgrades to services
- Potential service capacities for any upgrades

Your early attention to providing this information is greatly appreciated as the proponent requires the completion of the servicing assessment before Christmas.

If you have any queries or wish to discuss information requirements please do not hesitate to contact me on 9355 1300.

Regards,

James Bridge



T: (08) 9355 1300
F (08) 9355 1922
M: 0439 772 003
E: jbridge@shawmac.com.au



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